FOUR COMMON SEED-DESTROYING SPARROWS.

1, Junco; 2, White-throated Sparrow; 3, Fox Sparrow; 4, Tree Sparrow.

BULLETIN NO. 15

U. S. DEPARTMENT OF AGRICULTURE
DIVISION OF BIOLOGICAL SURVEY

THE RELATION OF SPARROWS TO AGRICULTURE

BY

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WASHINGTON
GOVERNMENT PRINTING OFFICE
1901

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Biological Survey,
Washington, D. C., July 3, 1901.

Sir: I have the honor to transmit herewith for publication as Bulletin No. 15 of the Biological Survey a report on "The Relation of Sparrows to Agriculture," by Dr. Sylvester D. Judd, assistant in this office. Sparrows are notorious seed eaters, but the precise nature of their food and its effect on agriculture have not hitherto been known with any degree of accuracy. This report, based on extended field observations and an examination of 4,273 stomachs of sparrows, brings out clearly the extent to which several native species feed on seeds of noxious weeds, and shows the value of these birds as weed destroyers.

Respectfully,

C. Hart Merriam,
Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

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IMPORTANCE OF SPARROWS.

The native sparrows are the most abundant and widely distributed of the small birds inhabiting the rural districts of the United States. Wherever there are farms these characteristic little birds may be found nesting in orchard, berry patch, vineyard, or hedgerow, enlivening the shrubbery from dooryard to outlying field with their songs, or in winter rising from the ground and fluttering from bush to bush before one who invades their haunts. As a group they are constantly present on cultivated land, although many of them retire to the South during the winter and their places are taken by other species from the North.

Sparrows are well known, and have figured frequently in ornithological literature, but the position they occupy in relation to agriculture has heretofore received only casual consideration. It is evident that a group of birds so abundant, so widely distributed, and in such constant association with farms and gardens must play an important part in rural economy, and that a thorough investigation of their food habits should be useful. The results of such an investigation are embodied in the present paper and amply demonstrate the value of these birds to the agriculturist—a value greater than that of any other group of birds whose economic status has thus far been investigated. The native sparrows contrast markedly in this respect with the introduced English sparrow, the pernicious habits of which have formed the subject of a special report,[1] and are briefly treated in this bulletin for purposes of comparison (see p. 92). This naturalized sparrow is a pest wherever it is found, while the native sparrows are well worthy of protection and encouragement.

CONSTITUENTS OF FOOD.

The great bulk of the food of sparrows and other small passerine (or perching) birds consists of fruit, seeds, and insects. The fruit may be wild berries taken from shrubs or trees of no economic importance, with little economic result whether the bird eats much or little; or it may be cultivated fruit, in which case, of course, it is desirable to know the amount destroyed.

[1] The English Sparrow in North America, Bull. No. 1, Div. Ornith. and Mamm., 1889.

The seed element is of particular interest only when it shows destruction of grain or weeds. Injury to grain or fruit by birds is usually the most prominent and often the only fact of economic ornithology possessed by the layman; yet comparatively few birds harm either of these crops, while many species render important service to agriculture by destroying weed seed. As has been aptly said, a weed is a plant out of place. Certain plants seem to have formed a habit of constantly getting out of place and installing themselves in cultivated ground, but whether actually among crops or in adjacent waste land, from which they can spread to cultivated soil, they are always a menace. In the garden they occupy the room allotted to useful plants, and appropriate their light, water, and food. Any check on these noxious interlopers, a million of which can spring up on a single acre, will not only lessen nature's chance of populating the soil with worse than useless species, but will enable the farmer to attain greater success with cultivated crops. The hoe and cultivator will do much to eradicate them, but some will always succeed in ripening a multitude of seeds to sprout the following season. Certain garden weeds produce an incredible number of seeds. A single plant of one of these species, as purslane, for instance, may mature as many as 100,000 seeds in a season, and these, if unchecked, would produce in a few years a number of weeds utterly beyond comprehension. The habits of some of the common weeds are considered in connection with the discussion of the value of birds as weed destroyers (see pp. 25–28).

FIG. 1.—Cutworm and moth (after Howard; loaned by Division of Entomology).

FIG. 2.—Grasshopper (after Riley; loaned by Division of Entomology).

The animal food of the smaller land birds consists of insects and spiders. The insects belong for the most part to the orders Lepidoptera (butterflies and moths), Orthoptera (grasshoppers, locusts, and crickets), Diptera (flies), Hemiptera (bugs), Coleoptera (beetles), and Hymenoptera (ants, bees, and wasps). Lepidoptera, Orthoptera, and Coleoptera furnish the bulk of the insect food of birds. The lepidopterous food is taken almost entirely in the larval condition, and comprises smooth caterpillars belonging largely to the family Noctuidæ, which includes cutworms (see fig. 1), army worms, and their allies. The Orthoptera eaten are principally long- and short-horned grasshoppers (Locustidæ

and Acrididæ—see fig. 2). Coleoptera form a most important element of bird food, the families of this order most largely represented being the Scarabæidæ or scarabæid beetles, the Carabidæ or ground-beetles, the Elateridæ or click-beetles, the Chrysomelidæ or leaf-beetles, and the Rhynchophora or weevils. Some of the scarabæids that are eaten are the clumsy brown May-beetles and their allies, which feed on growing plants; others comprise a group of beetles commonly known as dung-beetles, because they subsist on the droppings of animals. Ground-beetles are alert, active insects, carnivorous in food habits. Click-beetles are narrow and hard-shelled; when disturbed, they curl up and 'play possum' until the danger appears to be past, when they spring into the air by spasmodically straightening out their bodies with a sharp clicking sound. Their larvæ, wireworms, are often very destructive to crops. The leaf-beetles (see fig. 3) taken by birds are pests of little economic importance. Weevils (see fig. 4) constitute a destructive class of insect pests, and are extensively preyed on. Diptera furnish no significant part of the food of birds, though the slow-moving crane-flies (Tipulidæ) and midges (Chironomidæ) are at times snapped up, and some larval Diptera are occasionally eaten. The Hemiptera include both leaf-hoppers (Jassidæ), which derive their sustenance by probing plants with their sucking beaks, and true bugs, which are flat, bad-smelling insects. Some of the bugs feed like leaf-hoppers on the juices of plants, while others are predatory and subsist on succulent insects. The hymenopterous element of bird food is composed of ants, wasps, and a few small bees, the wasps including flower-fertilizing species and parasitic species of the families Ichneumonidæ (see fig. 5), Braconidæ, and Scoliidæ.

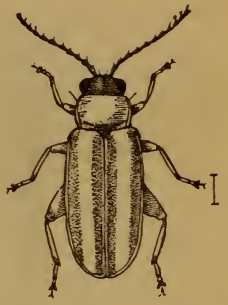

FIG. 3.—Leaf-beetle (*Systena blanda*) (after Chittenden; loaned by Division of Entomology).

FIG. 4.—Weevil (after Chittenden; loaned by Division of Entomology).

The value of a bird as an insect destroyer depends upon the value of the insects it consumes. Each insect eaten by birds must of necessity be injurious, beneficial, or neutral in its effect on crops, though it is not always easy to classify it properly. While present information is sufficient to fix the status of some with sufficient accuracy for all practical purposes, in the case of others more light is needed. The smaller dung-feeding scarabæid beetles appear to have little or no effect upon agriculture. The great majority of ants have habits which are apparently of little interest to the agriculturist;

and although some (of the genus *Lasius*), and perhaps others, possess certain injurious traits, while a few may have traits that are beneficial, yet the effects in any event are of minor importance; so that ants as a whole may safely be classed as neutral. Spiders, which for purposes of convenience are here classed with insects, are carnivorous, but their prey seems to include about as many beneficial insects as pests. The damage done by weevils, grasshoppers, and smooth caterpillars is notorious. Cutworms and army worms often do an immense amount of harm, and grasshoppers frequently occur in such voracious hosts that they sweep away every vestige of green vegetation before them. On the other hand, carnivorous ground-beetles (Carabidæ, see fig. 6) kill multitudes of insect pests, and certain parasitic wasp-like hymenopterous insects of the families Braconidæ, Chalcididæ, and Ichneumonidæ destroy great numbers of caterpillars. One of these parasitic insects will deposit in the back of a caterpillar from 20 to 2,000 eggs, which soon hatch into grub-like larvæ that feed upon the fatty tissues and exhaust the caterpillar so that it is not able to transform into a perfect insect.

FIG. 5.—Ichneumon fly (after Howard; loaned by Division of Entomology).

The fact that birds do not discriminate between insects that aid the farmer, such as parasitic Hymenoptera and carnivorous ground-beetles, and those that are harmful to his interests, led the entomologist, Benjamin D. Walsh, to deny their usefulness as insect destroyers. He asserts that the good done by the consumption of insect pests is more than counterbalanced by the destruction of useful species. His argument is that there are thirty times as many individual insect pests as there are insect enemies which subsist upon them, and that therefore no insectivorous bird can be considered a 'public benefactor' until it can be shown to destroy at least thirty times as many injurious as beneficial insects.[1] Applied to the destruction by birds of highly effective parasites of important pests which annually or at intervals cause a large loss to staple crops, Walsh's statement

FIG. 6.—Ground-beetle (after Riley; loaned by Division of Entomology).

[1] Practical Entomologist, Vol. II, No. 4, p. 47, 1867.

is probably adequate. But these conditions are seldom realized, and under any other so many factors are involved that the question is too complex to be so simply determined. A discussion of what is necessary to be considered in order to determine the status of a bird will be found in the chapter on 'Classification of Bird Food' (pp. 16–18).

METHODS OF INVESTIGATION.

Knowledge of the food habits of birds is of great importance in rural economy. Ignorance of this subject is in part responsible for the grave mistake which was made in the introduction of the English sparrow. To the same cause has been due the passage of bounty laws for the encouragement of the indiscriminate slaughter of hawks and owls, notwithstanding the fact that some of these birds of prey are highly beneficial to agriculture. To obtain adequate knowledge of the food of birds in relation to agriculture a definite scheme of procedure must be followed. Simply observing the birds while they are feeding gives only fragmentary information and has often resulted in the protection of injurious or the persecution of beneficial species. The results thus obtained must be supplemented by other and corroboratory evidence. Recent investigations by the Biological Survey have been carried out by the following methods: (1) Observation of birds in the field; (2) experiments with captive birds; (3) examination of the contents of stomachs; and (4) a combination of field work and stomach examination. Economic ornithology is as yet so little advanced that a detailed account of these methods will not be amiss.

FIELD WORK.

Field work, as stated, yields results which must not be considered as a final solution of the problem, but only as a contribution to our knowledge. Nevertheless, it is indispensable as a part of the investigation, since the actual amount of damage done to ripening fruit or to grain or the good done by the destruction of weed seed or insect pests by native birds can best be determined, in dollars and cents, by careful study of the scene of action. As an illustration of damage that could not have been ascertained by any other means an instance may be cited of a ripening oat field of 3 or 4 acres that was visited by a flock of about 100 goldfinches, where the quantity of grain actually eaten was insignificant, but a loss of 5 percent of the crop was caused on about an acre by the birds, breaking down the stalks so as to make it impossible to reap at that point. The extent of the good done by sparrows in destroying the seeds of pigeon-grass, ragweed, and similar weeds can be definitely ascertained only by visiting the field in late winter and observing the proportional extent of destruction. Such visits will often show that more than nine-tenths of the seeds produced have been destroyed. Field observation is useful also in ascertaining the food habits of nestling birds. Although the work

of identifying in the parent's beak the insects usually fed to nestling birds is exceedingly difficult, yet it yields more satisfactory results than examination of the stomachs of the nestlings, not only because stomach examination shows nothing as to frequency of meals, but also because the soft insects given by most of the smaller birds to their young are generally unidentifiable in the stomach.

EXPERIMENTS WITH CAPTIVE BIRDS.

Very often birds that are too shy to be watched in the field may be kept in captivity and experimented with. If the experiments are carefully conducted much can be learned as to the amount of food eaten, preferences in food, and questions relating to the dissemination of the seeds of fruit and weeds by birds. Birds selected for experiment should be recently trapped, because those that have been long in confinement usually develop unnatural tastes. In testing preferences in insect food it is convenient to place the insects on a piece of cork anchored in the center of a bowl of water. This prevents them from escaping and makes the conditions almost identical in the case of each kind. The insects should be equal in volume. Thus, a fair experiment would be made if a ladybird (*Coccinella 9-notata*) and a 12-spotted cucumber beetle (*Diabrotica 12-punctata*) were both put on the cork island at once for the bird to select from, because both insects are of about the same size. The same principles apply to fruits and seeds, though, of course, the use of the cork is not important in their case. The food of nestling birds may be sometimes studied to advantage by removing the young from the nest and placing them in a cage almost out of reach of the parent bird, so that in feeding them the latter will drop a large proportion of the food just inside the cage.

LABORATORY EXAMINATION OF STOMACHS.

The contents of the crops (or gullets) and stomachs of wild birds are examined to find just what elements of food the bird has chosen and the proportion each bears to the total amount of food; and if the number of stomachs examined be large enough, the difference due to individual variation is eliminated. The identification of the food found in a bird's stomach is difficult, for two reasons: (1) Because of the great variety of substances that may be found in the stomach, and (2) because of the fact that the semi-digested pieces and fragments of insects, fruits, and seeds are often so comminuted that exact identification is well-nigh impossible. The method of procedure employed in the laboratory of the Biological Survey in making stomach examinations is as follows: The stomach is slit open with a scalpel, and its contents are first washed into a pan by a jet of water from a wash bottle and then, with the exception of the sand and gravel, poured into a


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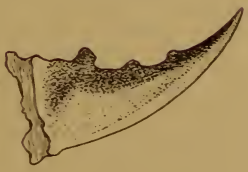
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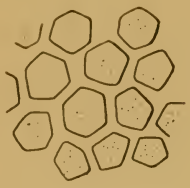
FRAGMENTS OF INSECTS FOUND IN BIRDS' STOMACHS.

1. Mandible of grasshopper.
2. Scale of moth.
3. Tibio-femoral plate of grasshopper.
4. Clasper of May-beetle.
5. Prosternum of click-beetle.
6. Mandible of cutworm.
7. Wing-cover of weevil.
8. Mandible of larval ground-beetle.
9. Mandible of ant.
10. Mesothorax of black wasp.
11. Egg of May fly.
12. Scutellum of bug.



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FRAGMENTS OF GRAIN AND FRUIT FOUND IN BIRDS' STOMACHS.

1. Starch grains of corn.
2. Starch grains of wheat.
3. Starch grain of oats.
4. Epidermis of cultivated cherry.
5. Epidermis of wild red cherry.
6. Granule of poison ivy.
7. Bayberry.
8. Granule of bayberry.

beaker. The beaker is then held under a faucet, so that the rush of water will cause whatever insect remains may be present to float to the surface, where they can be decanted off with a filter of bolting cloth. The remaining matter in the beaker (generally seeds and fruit skin) is then collected on another filter, and from the two filters the material is transferred by means of a scalpel to separate smooth blotters about 3 inches square, and is ready for examination. Examinations are usually made with a dissecting microscope furnished with an achromatic triplet lens, but occasionally it is necessary to employ the higher powers of the compound microscope.

The principal difficulty arises from the fact that birds often mutilate their food before swallowing it, and the gizzard afterwards reduces it to fine fragments. A song sparrow, for example, will seize a grasshopper, pinch it a dozen times, pull off and eat the head, pull off the legs and wings and then swallow the abdomen, leaving the other parts. In the gizzard, with its powerful muscular walls, the reduction of the insect is more complete, so that usually within two hours only a few bits of grasshopper dust remain. It is with such material that the examiner has most often to deal. But with practice his eye quickly detects amidst this dust a squarish, bicolored jaw with a grooved cutting-edge behind which is a grinder (see Pl. II, fig. 1). If the jaw is lacking, a little search seldom fails to reveal a tiny piece that looks like a human ear, but in reality is part of the knee-joint of the grasshopper (see Pl. II, fig. 3).

FIG. 7.—Jaw of May-beetle (top and side views).

The remains of caterpillars found in bird stomachs usually consist of the discolored broken skin, which has been twisted and rolled into compact little packets by the action of the stomach. Sometimes nothing is left by which to identify the insect except the concave jaws, the prominent spherical condyles of which, however, are unmistakable (see Pl. II, fig. 8). Butterflies and moths may be distinguished by the tiny tooth-scales of the wing (see Pl. II, fig. 2) when the naked eye is unable to detect the presence of these insects. Beetles resist digestion more than caterpillars and grasshoppers, consequently pieces of their hard shells may be found in the stomachs for some time. These and other fragments serve to distinguish the different kinds. The hard parts of the genital organs of different species of May-beetles (see Pl. II, fig. 4) are very distinctive in character, and so afford ready means of identification. The blunt, curiously shaped jaws (see fig. 7) are also characteristic. The hinged body of a click-beetle is provided with a tooth which strikes against half of the hinge and causes the click that is heard as the beetle springs into the air (see Pl. II, fig. 4). This tooth when met with in a bird's stomach is often

broken off from the body, and is sometimes all that is left to show that a click-beetle has been eaten. The pitted, earthenware-like wing-covers of weevils (see Pl. II, fig. 7) and the curved, sharp jaws of ground-beetle larvæ are easily recognizable (see Pl. II, fig. 7). The identification of Hymenoptera is much more difficult, as the distinguishing features are found mostly in the veining of the delicate wings, which are exceedingly perishable. Ants, however, can always be recognized by the very hard jaws even when the action of the stomach has practically reduced the insect to dust (see Pl. II, fig. 9). Certain black wasps (*Tiphia inornata*) often eaten by birds may be recognized in the stomach by the presence of a tiny piece of the crust of the insect's back (mesothorax), which is sculptured by three parallel raised ridges (see Pl. II, fig. 10). The presence of female May-flies can usually be detected by means of the prettily reticulated eggs from within the insect's body and the golden globule of oil each contains (see Pl. II, fig. 11). Bugs (Heteroptera) may be determined by their back shields (scutella), which are marked with dark dots and in shape closely resemble equilateral triangles (see Pl. II, fig. 12); spiders by their jaws, which look like miniature cow horns, and their minute eyes, which resemble clusters of gleaming gems (see fig. 8). The remains of earthworms are identified with the compound microscope, the high-power lenses of which reveal the characteristic amber-colored S-shaped spicules (see fig. 9) with which the bodies of the worms are beset. These lenses are also employed in identifying bits of the skin of fruits and pasty masses of the endosperm, or meaty part, of seeds. Differences can thus be perceived in the structure of the epidermis of many fruits (see Pl. III, figs. 4 and 5) and the starch grains of common cereals (see Pl. III, figs. 1, 2, and 3). When a bird has eaten poison ivy there often remains nothing of the fruit except certain black, club-shaped bodies (see Pl. III, fig. 6) which coat the stone below the white skin of the fruit. The stones of bayberries are similarly covered with small granules (see Pl. III, figs. 7 and 8), which furnish the clew in each case when the stones are absent.

FIG. 8.—Eyes of spider.

FIG. 9.—Spicule of earthworm.

After each element in a bird's stomach has been identified and placed in a separate pile, the percentages of the different elements are estimated by volume.[1] In recording the results of examinations a separate record is made for each species and for each month. Monthly averages are based on the number of stomachs collected in

[1] Of course it must be understood that mathematical exactness is not attainable in these examinations: but every possible means is taken to reduce the error to a minimum, and with a sufficient number of stomachs a very correct idea may be obtained of the proportions of the different elements of the food.

the month, but yearly averages are determined from the monthly averages; for unless the collections of stomachs were much more evenly distributed as to months than they are at present, an average based directly on the number of stomachs collected in the year would be misleading.

COMBINATION OF FIELD AND LABORATORY WORK.

Although the examination of a bird's stomach shows just what the bird has eaten, yet if this alone be depended upon information is still wanting as to what has been refused or what preferences exist, since the different elements of the food supply in the locality where the stomach was collected are not taken into account. If, however, this lacking information be obtained by means of field observation and used in connection with stomach examination, the examiner will be enabled to make his analyses with the fullest degree of accuracy.

In pursuance of this plan I have for several years systematically visited various farms in the neighborhood of Washington and collected data and material relating to the available food supply, to be used in connection with the examination of the stomach contents of birds collected in these localities. One example will serve to illustrate this method. On May 13 and 18, 1898, I visited a farm of 75 acres, mostly under cultivation, which was situated in a shallow depression surrounded by woodlands. It was traversed by three small bushy brooks, which ran among some cabbage plats, apple orchards, and cornfields (some newly sown and some with the last season's stalks). Between the cabbage rows was chickweed; in the apple orchard were the last year's stalks of lamb's-quarters with but few seeds, and in the old cornfield were great quantities of pigeon-grass and smartweed, though scarcely any seeds were left. Birds were numerous along the brooks and ran out into the fields among the dead weed-stalks, picking up food from the ground. The kinds of insects present were carefully noted and then the birds were watched with a glass for two hours, after which 17 sparrows, including field, chipping, white-throated, English, song, and Lincoln's sparrows, were collected and their stomachs examined. Four had eaten seeds of lamb's-quarters and smartweed; 5, chickweed; and 6, crab-grass and pigeon-grass; 5 had taken cutworms (whose ravages had made it necessary to replant the cabbages twice); 6 had eaten small dung-beetles, and 10 had eaten weevils, specimens of which had been previously taken with a net on strawberry and clover. A dozen grasshoppers had also been collected, but only 2 birds had eaten any. Useful predaceous ground-beetles (Carabidæ) were very numerous and easily accessible, but the sparrows had eaten only one, while several other birds shot at the same place had eaten freely of them.

From the knowledge gained by the study on this farm one could, with a fair degree of accuracy, predict what kind of food sparrows

would eat on another farm where the food supply was identical. This line of research might be continued until it could be foretold with reasonable certainty which of the different objects in the accessible food supply of a locality a given bird would probably select.

In recapitulation it may be stated that in the investigation of the food habits of any bird the first thing to be done is to examine enough stomachs to obtain a general idea of the bird's food, so that intelligent field work may be done. Then the observer should go to some favorable spot, note carefully the different kinds of available food, watch the birds feeding for a while, and collect stomachs for examination. In this way it will be possible to ascertain what a bird will eat, what it prefers, and what it will refuse.

CLASSIFICATION OF BIRD FOOD.

To aid in reaching final conclusions as to the economic position of a bird it has been found convenient to divide the food into three categories according as its consumption tends to produce a (1) beneficial, (2) injurious, or (3) inappreciable effect on agriculture. The beneficial part consists chiefly of insect pests and weed seed, the injurious part consists largely of insect enemies of insect pests and plunder from cultivated crops, and the neutral part comprises neutral insects and the fruits and seeds of plants of no economic importance. The relations which these three parts of the food bear to one another determine in large measure the economic status of a bird.

Of course, there can be no hard and fast rule in the matter. The beneficial and injurious elements of the food are marked by infinite degrees of gradation, and quality must be considered as well as quantity. The importance of the consumption of wheat varies greatly according to whether the grain is taken from the newly sown field, the growing crop, the stubble, or the shock. Insects may be either serious pests or insignificant in power to damage crops, with every shade of injuriousness between these extremes.

The abundance of a bird has also much weight in fixing its value. A species must be numerous, must live among cultivated crops, and must take food that has a close connection with agriculture in order to produce any significant effect on the farm.

The neutral element of the food must not be overlooked. The greater its proportion the more abundant must the bird be in order to produce any effect either one way or the other. With many shore and woodland birds it is so large, in comparison with the injurious or beneficial parts, that it is likely that such birds have scarcely any effect in rural economy.

These and many other like factors have to be considered in deciding a bird's economic status; but for a rough general estimate it is safe to assume that a bird that feeds on insects, seeds, and fruit, and is abundant on a farm, will do more good than harm, and usually be

worthy of protection when the neutral part of its food forms less than half of its entire food and its beneficial food amounts to several times its injurious food. The native sparrows, it may be added, seem to satisfy these conditions better than any other equally large group of birds.

Exceptional habits must also be considered in determining a bird's value, for they sometimes overshadow in importance the general food habits. Thus a single species or several allied species may become exceptionally abundant for a month or two in a very limited district devoted largely to a single crop on which they feed. An illustration of this is the autumnal migration of bobolinks and red-winged blackbirds when the birds converge and swarm into the limited area of the rice districts so as to destroy annually $2,000,000 worth of the crop.[1] Some species of birds act as agents in the distribution of the seeds of noxious plants, as in the case of the crow, which is in a measure responsible for the widespread distribution of poison ivy. Certain species which have beneficial food habits themselves destroy still more useful species, as exemplified by the cowbird when it parasitizes the song sparrow. The English sparrow, which does more good than harm to vegetation in the city park (though it has objectionable food habits in rural districts), overbalances this good and becomes a pest because of its filthy habits.

But it is not easy to determine the exact relation of birds to agriculture, even though all the constituents of the food are known; for the actual ratio of benefit to injury in the food habits can only be roughly approximated, and it is often a question of nice judgment to determine the final status of a particular species. The benefit is usually, if not invariably, indirect, while the injury may be either direct or indirect. When the English sparrow steals food from a flock of chickens the harm is direct; but when it preys on *Tiphia inornata*, a species of wasp, it is doing an indirect harm, because this wasp parasitizes the larvæ of May-beetles, which are exceedingly injurious to crops. So, too, when the chipping sparrow feeds on the cabbage worm (*Pieris rapæ*) it is accomplishing an indirect good, because if the worms increased unduly they would destroy the whole cabbage patch.

While the direct effects are easily observable, the indirect effects are usually obscured. Their complexity is frequently baffling to the investigator who is in search of economic conclusions. One is brought face to face with most perplexing problems resulting from the interaction of organisms—problems which not only embrace the complex interrelations among animals and plants, but also include the relations of organic life to its inorganic environment. The drawing of sound economic conclusions is impossible until the far-reaching influence of this interaction is at least thoroughly appreciated if not

[1] Ann. Report Dept. of Agr., for 1886, p. 247, 1887.

entirely understood. The difficulties involved are well illustrated by certain observations made by Dr. J. A. Allen. He found the tree, chipping, field, and white-throated sparrows, and the junco preying upon an insect pest of the apple, the apple-tree plant-louse (*Schizoneura lanigera*).[1] This was, of course, a beneficial effect rendered by the birds, but at the same time they were killing the larvæ of the ladybirds, lacewings, and syrphus flies, which were also destroying the plant-lice. It would be necessary to ascertain to what extent the evil effect of killing the enemies of the plant-louse counterbalanced the good effect of killing the plant-louse itself before the final effect of the sparrows upon apple culture could be determined.

RECAPITULATION.

By keeping in mind the exceptional ways in which birds become pests, and by inspection of the food elements of sparrows through the different methods of investigation heretofore described, more especially through the combination of field work with stomach examination, and further by the classification of these elements of the food into their neutral, beneficial, and injurious categories the effect of sparrows on cultivated crops can be approximately ascertained.

[1] *Vide* B. D. Walsh in The Practical Entomologist, Vol. II, No. 4, p. 46, 1867.

FOOD OF SPARROWS.

The following conclusions upon the relations of sparrows to agriculture are based upon the study of the food habits of a score of species,[1] and have involved the examination of the contents of the stomachs of more than 4,000 individuals. These stomachs were collected during every month in the year from a large expanse of country, including practically all the States in the Union and the southern part of the Dominion of Canada.

MINERAL SUBSTANCES FOUND IN SPARROWS' STOMACHS.

Mineral matter plays a part in the digestion of sparrows and often amounts to one-tenth or one-quarter of the total contents of a stomach. These birds are preeminently seed eaters. Insectivorous birds with soft, weak bills and thin membranous stomachs could not possibly eat and digest a meal of tough, resisting seeds; but the hard, strong beaks and powerful, muscular gizzards of sparrows are admirably adapted to such a diet. Sparrows swallow the smaller seeds whole, but crack the larger ones. To aid digestion they pick up, while feeding, coarse bits of sand and tiny stones, which, in their mill-like gizzards, soon grind the seed material into a paste that can be as easily digested and assimilated as if it had been chewed by teeth. This mineral matter usually consists of angular white or pink pebbles of quartz from 2 to 5 mm. in diameter. Pieces of feldspar, tourmaline, mica, and even volcanic lava are sometimes found, and in Kansas the birds often utilize the disk-like sections of stems of fossil sea-lilies (*Crinoidea*—see fig. 10). A sooty grouse taken in British Columbia had swallowed for this purpose four little nuggets of gold.[2]

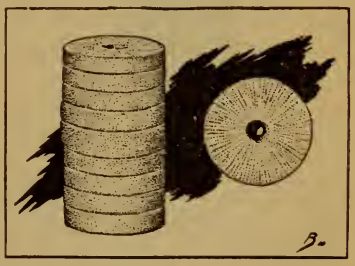


FIG. 10.—Section of stem of fossil sea-lily.

FOOD IN GENERAL.

Of the food of sparrows, animal matter composes from 25 to 35 percent of the diet for the entire year, and vegetable matter from 65 to 75 percent. The animal food consists of insects and spiders and

[1] The remainder of the native sparrows, which are mostly birds of more or less limited numbers or restricted distribution, are not considered in this bulletin, owing to lack of material for adequate study.

[2] Forest and Stream. Vol. XXXIV. p. 431, 1890.

occasionally includes snails or millipedes; insects—mainly grasshoppers, beetles, and caterpillars—constitute more than nine-tenths. The vegetable food is composed almost entirely of seeds, although it also comprises a small quantity of fruit.

FOOD NEUTRAL IN EFFECT ON AGRICULTURE.

The neutral part of this food is made up principally of certain insects, spiders and snails, a small amount of wild fruit, and some seeds of useless plants. Insects form about four-fifths of the animal matter of the neutral part, comprising ants and certain kinds of flies and beetles. The flies, which are usually adult insects, but sometimes larvæ, include midges (Chironomidæ), flies related to the house-fly (Muscidæ), March-flies (Bibionidæ), and crane-flies (Tipulidæ). These insects never amount to 1 percent of the volume of the entire food of any species of sparrow for the whole year. May-flies (Ephemeridæ), emerging from the water by the million, are preyed on by the sparrows that dwell in the immediate vicinity of streams or ponds. Ants seldom equal 2 percent of the volume of the year's food. Both typical ants (Formicidæ) and myrmicids (Myrmicidæ) are taken. Such ants as *Formica fusca* and *F. subsericia*, *Lasius*, *Myrmica*, and *Tetramorium* are frequently selected. They are often eaten while yet in the winged state and are then caught in the air. Beetles of little or no economic importance amount to from 3 to 5 percent of the total volume of the food for the entire year. These are for the most part dung-feeding species belonging to the genera *Aphodius* (see fig. 11), *Ataenius*, *Onthophagus*, and *Hister*. They are often found by hundreds in cow droppings in pastures.

FIG. 11.—Dung-beetle (*Aphodius*) (loaned by Prof. S. A. Forbes).

The remainder of the neutral part of the food is made up of spiders and snails. Spiders, though predatory, have not as yet been classed as useful, because, as already stated, as a group they seem to destroy about as many beneficial as injurious insects. The kind most frequently eaten by sparrows are the running ground-spiders, which, though probably more useful than harmful, are of too little importance to be classed otherwise than as neutral. They constitute 1 to 3 percent of the food. A few snails are eaten. These are as a rule not injurious; and though an exception should be made of the pond snail (*Limnæa*), which acts as intermediate host to the liver fluke, a pest to sheep raisers, probably very few if any of these are included among the small number of snails actually eaten, and they may be disregarded.

FOOD INJURIOUS IN EFFECT ON AGRICULTURE.

The injurious part of the food of sparrows, the removal of which tends to cause a harmful effect upon crops, is made up of useful insects and spoils from cultivated crops, such as grain and fruit. Beneficial insects seldom amount to more than 2 percent of the food. They consist mostly of enemies of insect pests and a very few flower-fertilizing species, such as certain wasps and some small bees of the genera *Andrena* and *Halictus*. The insect enemies are either ground-beetles (Carabidæ) or parasitic wasps. The particular ground-beetles selected belong to the less useful predatory kinds. They are small species, the exact economic position of which is not yet known, and include *Amara*, *Anisodactylus*, *Agonoderus*, *Bembidium*, and the smaller species of *Harpalus*. One species—*Agonoderus pallipes*—has been found injurious to grain, and in time it and some other slightly carnivorous carabids may become pests like the related *Zabrus gibbus* of Europe. The parasitic Hymenoptera include such wasps as the smaller Ichneumonidæ, the larger Braconidæ, and Scoliidæ of the genera *Myzine* and *Tiphia*. But the quantity of useful insects eaten by sparrows is small; omitting those taken by the English and field sparrows, it is insignificant. And though 4 percent of the food of the latter consists of useful insects—a larger percentage than is attained by any other member of the sparrow family—yet this record is very favorable compared with those of many birds. The loggerhead shrike and the king-bird, for example, take 12 percent and 20 percent, respectively, of their food in beneficial insects, and there are other birds whose records are still less creditable.

Cultivated fruit forms no significant part of the food of sparrows. The white-crowned sparrow occasionally punctures a few grapes in the East; the English sparrow adds more or less fruit destruction to his many other sins; and it is probable that one or two western species do some little damage of this kind: but with these exceptions the sparrow family is harmless to orchard and vineyard.

The English sparrow does so much damage to grain that it is considered a pest, and the native sparrows might naturally be suspected of having similar habits; but though they frequently sample grain in stubble-fields, they have not as yet been found committing serious depredations. In order to compare the grain-eating propensities of the various species, specimens were collected on a farm a few miles south of Washington, D. C., before and after the wheat was cut. Of nineteen native birds, representing song, field, chipping, and grass-hopper sparrows, only two had eaten grain, and these had taken only one kernel each, while, on the other hand, of five English sparrows that were examined every one was gorged with wheat. On this particular farm flocks of English sparrows pillage the wheat crop from the time it comes in milk until it is threshed; and attack corn in

the roasting-ear stage, and feed on it from the time it is put in the crib until wheat comes in the milk again in June. There is scarcely a grain that they do not injure, while with the native sparrows the reverse seems to be true. The latter eat a little grain, but seldom does it amount to more than 5 percent of the year's food, a modest fee for their service when it is considered that the meadowlark, one of the best birds of the farm, takes 13 percent of its food in grain, the crow 35 percent, and the crow blackbird 47 percent.

The most serious charge that can be brought against sparrows is that they distribute noxious plants, the seeds of which pass through their stomachs and germinate when voided from the body; and this, though not strictly germane to the subject under consideration, will be treated of here as the most appropriate place. Sparrows do not distribute catbrier, poison sumach, and poison ivy, as do many birds, but it is probable that they do, to a certain extent, disperse the seeds of such weeds as amaranth, gromwell, and spurge. However, it seems likely that this agency of seeding down farms to weeds is infinitesimal when compared with the dispersion of weeds caused by the use of manure containing weed seed and the planting of impure seed, which often contains seeds of foreign weeds of the worst stamp. The digestive apparatus of sparrows has the power to crack or crush the seeds of crab-grass, pigeon-grass, pigweed, lamb's-quarters, and most other seeds, including the hard drupes of the blackberry. I have examined thousands of stomachs of sparrows containing ragweed, and have never found an unbroken seed. The outer ribbed shell of the akene is cracked and not swallowed, but parts of the true seed coat in the shape of angular fragments 3 to 5 mm. long, which are dirty gray externally and greenish white internally, are usually found during stomach examination. Uncrushed cotyledons are seldom met with. These facts, which hold also when seeds of wild sunflowers and polygonums are eaten, seem to preclude the possibility of subsequent germination. Concerning the likelihood of the germination of the seeds of weeds that are grasses it may be stated that time and again tree sparrows which have fed on pigeon-grass have been examined, and it has been found that while their gullets contained from 100 to 300 whole pigeon-grass seeds with the inner glumes removed, the gizzards were filled with a pasty mass of endosperm containing not more than a dozen whole seeds. But with the harder, smaller seeds the possibility of germination is better. The digestive organs, although they have the power of cracking such seeds, nevertheless occasionally allow some to pass out in a perfect condition, as was shown by an experiment with a captive song sparrow in which amaranth seeds were voided uninjured and germinated very well. Birds take seeds for food, however, and it seems probable that such use would preclude the evacuation of any but a most insignificant proportion of uninjured seeds.

FOOD BENEFICIAL IN EFFECT ON AGRICULTURE.

The beneficial part of the food of sparrows is made up of insect pests and the seeds of weeds. Insect pests amount to from 10 to 20 percent of the year's food, and are for the most part grasshoppers (Acrididæ and Locustidæ), caterpillars, principally Noctuidæ (that is, cutworms, army worms, and their allies) and some Geometridæ, such as cankerworms and their allies, and beetles of various families—Chrysomelidæ or leaf-beetles, Elateridæ or click-beetles, and Rhynchophora or weevils. Conspicuous among the genera of beetles met with in stomachs of birds are *Systena*, *Epitrix*, *Odontota*, *Limonius*, *Drasterius*, *Sitones*, and *Phytonomus*. Bugs are eaten to an unimportant extent, and constitute about 1 percent of the food. The plant-feeding forms include such Heteroptera as some of the smaller soldier bugs (Pentatomidæ), leaf-bugs (Capsidæ), a few such Homoptera as leaf-hoppers (Jassidæ), and in very rare instances plant-lice (Aphididæ). Insects seldom form more than a third of the food of adult sparrows for the year, but their nestlings are practically entirely insectivorous; on which account these birds, in raising from two to three broods a season among agricultural crops, do their greatest good as destroyers of insect pests by cramming countless numbers of caterpillars and grasshoppers down the throats of their ravenous young. Some grasshoppers are much more injurious than others. The most destructive species is the Rocky Mountain locust (*Melanoplus spretus*—see fig. 12), which at intervals invades the plains of the central United States in such numbers as to actually hide the sun. These insects travel onward, sweeping away every vestige of green vegetation in their path, and bringing destruction and desolation to thousands of farms. As shown by the investigations of Prof. Samuel Aughey in Nebraska,[1] the native sparrows perform a useful part in aiding to check these invasions.

FIG. 12.—Rocky Mountain locust (after Riley; loaned by Division of Entomology).

In studying the efficiency of birds in checking an uprising of the cankerworm (*Anisopteryx vernata*) in Illinois, Prof. S. A. Forbes collected birds in a bearing apple orchard which had been so injured by the worms for several years that it looked as though it had been swept by fire. Among these birds were the grasshopper sparrow, the chipping sparrow, the field sparrow, and the dickcissel. The examination of their stomachs showed that although cankerworms were not eaten by the grasshopper sparrow, they amounted to 16⅔ percent of the food of the chipping sparrow, 23½ percent of that of the field sparrow, and 43 percent of that of the dickcissel.[2] Nearly all spar-

[1] First Ann. Report U. S. Entomological Commission, App. II, pp. 29–32, 1878.
[2] Bull. Ill. State Laboratory Nat. Hist., Vol. I, No. 6, p. 12, 1883.

rows prey on cankerworms and other members of the family Geometridæ. They also have a decided taste for cutworms, army worms, and their allies, in destroying which the song, field, chipping, grasshopper, and lark sparrows, and the dickcissel are especially effective.

But adult sparrows can not be depended upon to check invasions of certain insect pests, especially hairy caterpillars, because they do not eat them. With orchard trees and others festooned with the webs of the fall webworm, I have seen the sparrows, although they were abundant in the vicinity, refuse these insects and select others. At Marshall Hall, Md., on the level bluff across the Potomac from Mount Vernon, is a fertile farm, on which the field habits of sparrows have been carefully studied (see pp. 29–45). On this farm during August, 1898, the tobacco worms practically ruined the tobacco crop. I collected there at that time 50 sparrows, representing the chipping, song, field, grasshopper, Henslow's, and English sparrows, but subsequent stomach examination showed that only one of these birds had eaten a tobacco worm.

FIG. 13.—Four common weeds the seeds of which are eaten by sparrows: *a*, amaranth; *b*, crab-grass; *c*, ragweed; *d*, pigeon-grass.

Weevils, especially such as injure clover and strawberries, they destroy in large numbers, which is surprising, considering that these insects are hard-shelled and protectively colored. They eat some species of leaf-beetles (Chrysomelidæ) also, but refuse others. Thus they avoid the potato beetle (*Doryphora 10-lineata*), the two 12-spotted cucumber beetles (*Diabrotica 12-punctata* and *D. vittata*), and the bean flea-beetle (*Ceratoma trifurcata*), but consume some of the less important pests of the bean. The song, field, and chipping sparrows eat the locust leaf-mining beetle (*Odontota dorsalis*) and two species of striped flea-beetles (*Systena blanda* and *S. elongata*).

But although sparrows render considerable service by helping to reduce the number of insect pests, by far their most important work consists of the wholesale destruction of the seeds of weeds (see fig. 13). Each fall and winter they flock in myriads to agricultural districts and live on the ripened seeds of weeds. As they attack weeds in their most critical stage, that of the seed period, it follows that their services must be of enormous practical value. The benefits are greatest in the case of hoed crops, since among these are found the largest number of annual weeds, which, being killed by frost, must depend for perpetuation solely upon seeds. The principal weed seeds prevented by sparrows from germinating are those of ragweed, pigeon-grass, smartweed, purslane, bindweed, crab-grass, lamb's-quarters, chickweed, and amaranth (see fig. 14). It is sometimes asserted that no thrifty farmer will allow these noxious species to ripen seed, but such prevention is practically impossible, because even if all the edges of fields and all waste ground could be cleared, weed patches along ditches, roads, and hedgerows would still remain to disseminate seed to cultivated land. It is in just these places that sparrows congregate in greatest numbers. Some eat more or less weed seed throughout the year, even when insects are most abundant; but their work is chiefly from early autumn until late spring, and is perhaps most noticeable in winter when the ground is white with snow. It is then that the weed patches are all a-twitter with the busy seed-eaters. The birds form animated groups perched on the stalks or darting about on the ground beneath, winding their way in and out among the weeds. So bountiful is the supply, and so eagerly do they avail themselves of it, that the number of seeds consumed by each individual seems beyond the capacity of its little body. It is not at all uncommon for a field sparrow to eat 100 seeds of crab-grass at a single meal. In the stomach of a Nuttall's sparrow have been found 300 seeds of amaranth, and in another 300 seeds of lamb's-quarters; a tree sparrow that was examined had consumed 700 seeds of pigeon-grass at a meal, while a snowflake taken at Beaverdam, Wis., which had been breakfasting in a garden in March, had picked up 1,500 seeds of amaranth.

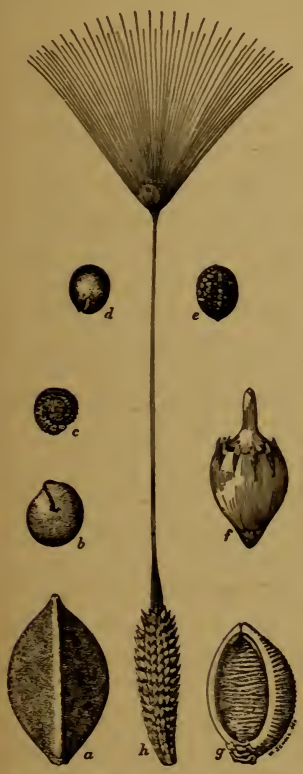


FIG. 14.—Weed seeds commonly eaten by sparrows: *a*, bindweed; *b*, lamb's-quarters; *c*, purslane; *d*, amaranth; *e*, spotted spurge; *f*, ragweed; *g*, pigeon-grass; *h*, dandelion.

English sparrows are also useful destroyers of weed seed. Thousands may be seen every autumn on the lawns of the Department of Agriculture feeding on crab-grass (*Panicum sanguinale*) and yard-grass (*Eleusine indica*), two weeds that crowd out good turf-making grasses. They deserve further credit for their good work in destroying seed of the dandelion (*Taraxacum taraxacum*), which is a prolific weed throughout the United States, especially in lawns and pastures, and is also troublesome in cemeteries. In the public parks of Washington, D. C., the birds eat these seeds from the middle of March until the middle of August, but chiefly in April and the first half of May, when the lawns are full of dandelions. After the yellow bloom has disappeared the head closes and a downy tuft appears at the upper end; in this stage it is most frequently attacked by the English sparrow. The bird removes several long scales of the inner involucre by a clean cut close to the receptacle or base of the head, thus exposing the plumed seeds or akenes. It seizes a mouthful of these akenes, lops off the plumes with its bill, and swallows the seeds. In many cases, especially when hungry, it does not take the trouble to remove the plumes. Generally it drops a score of seeds in tearing open a head, and usually leaves a few clinging to the edge of the receptacle.

The mutilation caused by the bird's beak can be detected until the flower stalk dries and falls. One day I examined every stalk in a rectangular space 6 feet 2 inches long by 3 feet 3 inches wide. Of the 413 stalks collected 358 showed unmistakable marks of the sparrow's bill. On the next day 293 stalks were gathered from a circle 2 feet in diameter on the other side of the lawn, and 275, or 93 percent, proved to be mutilated. These and similar observations made with varying results, covering several years, showed that at least three-fourths of the dandelions that bloom in April and May on the Department lawns are mutilated by birds. In this destruction of dandelion seeds, the English sparrow is aided by several native birds, chiefly the song sparrow, the chipping sparrow, and the white-throated sparrow. So far as observed, the native birds usually do not cut open dandelions, but simply feed on those left by the English sparrow. The song sparrow, however, is capable of getting out seeds alone; for one which was kept in captivity manipulated dandelions in precisely the same way as the English sparrow.

Besides such lawn weeds as dandelions, crab-grass, and yard-grass, several others, including pigeon-grass, knotweed, sedge, oxalis, and chickweed, furnish food for sparrows. These plants are also troublesome in other places than lawns. Knotweed (*Polygonum aviculare*) litters up paths and roads and grows in spots where turf is broken; chickweed (*Alsine media*) occurs in plowed ground; and pigeon-grass (*Chætochloa glauca* and *C. viridis*), which is considered one of the worst of weeds in Minnesota, is found among many crops. The seeds of these weeds are eaten by the song sparrow, chipping sparrow, field

sparrow, junco, English sparrow, tree sparrow, Gambel's sparrow, and white-throated and white-crowned sparrows.

Among the weeds which are troublesome in fields, especially among hoed crops, may be mentioned ragweed (*Ambrosia artemisiæfolia*), several species of the genus *Polygonum*—including bindweed (*P. convolvulus*), smartweed (*P. lapathefolium*), and knotweed (*P. aviculare*)—pigweed (*Amaranthus retroflexus*, and other species), nut-grass and other sedges (*Cyperaceæ*), crab-grass (*Panicum sanguinale*) and some other varieties of panic-grass, pigeon-grass (*Chætocloa viridis* and *C. glauca*), lamb's-quarters (*Chenopodium album*), and chickweed (*Alsine media*). Every one of these weeds is an annual, not living over the winter, and their seeds constitute fully three-fourths of the food of twenty species of native sparrows during the colder half of the year. Prof. F. E. L. Beal, who has carefully studied this subject in the upper Mississippi Valley, has estimated the amount of seed eaten by the tree sparrow, junco, and other sparrows that swarm down from Canada in the fall and feed in the rank growth of weeds bordering roadsides and cultivated fields. He examined the stomachs of many tree sparrows and found them entirely filled with weed seed, and concluded that each bird consumed at least a quarter of an ounce daily. Upon this basis, after making a fair allowance of the number of birds to the square mile, he calculated that in the State of Iowa alone the tree sparrows annually destroy 1,750,000 pounds, or about 875 tons, of weed seed during their winter sojourn.[1] The value of this work can best be appreciated by considering the annual loss to the farmer occasioned by the presence of weeds and the consequent reduction of cultivated crops. Mr. F. V. Coville, botanist of the Department of Agriculture, states that "since the total value of our principal field crops for the year 1893 was $1,760,489,273, an increase of only 1 percent, which might easily have been brought about through the destruction of weeds, would have meant a saving to the farmers of the nation of about $17,000,000 during that year alone."[2]

Besides tree sparrows and juncos, the most important sparrows that destroy weeds in the Mississippi Valley and on the Great Plains are the fox sparrow, the snowflake, the white-crowned sparrow, Harris's sparrow, and the different longspurs. Farther south are found the lark sparrows, and on the Pacific slope occur Nuttall's sparrow, the golden-crowned sparrow, and Townsend's sparrow. East of the Alleghenies the most active weed eaters are the tree sparrow, fox sparrow, junco, white-throated sparrow, song sparrow, field sparrow, and chipping sparrow. On one of the Maryland farms visited in 1896, tree sparrows, fox sparrows, white-throated sparrows, song sparrows, and juncos fairly swarmed during the month of December in the briers of the ditches between the cornfields. They came into the open

[1] Farmers' Bull. No. 54, U. S. Dept. Agriculture. p. 28, 1897.

[2] Bull. No. 17, Div. Botany. U. S. Dept. Agriculture, p. 3, 1896.

fields to feed on weed seed, and were most active where the smartweed formed a tangle on low ground. Later in the season the place was carefully examined. In a cornfield near a ditch the smartweed formed a thicket more than 3 feet high, and the ground beneath was literally black with seeds. Examination showed that these seeds had been cracked open and the meat removed. In a rectangular space of 18 square inches were found 1,130 half seeds and only 2 whole seeds. During the ensuing season no smartweed grew where the sparrows had caused this extensive destruction. Even as late as May 13 the birds were still feeding on the seeds of these and other weeds in the fields. Sixteen sparrows were collected on that date, and 12 of these, mainly song, chipping, and field sparrows, proved to have been eating old weed seed. So thoroughly had the work been done that diligent search showed only half a dozen seeds in the field where they had been feeding. The birds had taken practically all that were not covered; in fact, the song sparrow and several others had scratched up much buried seed.

In the greater part of the United States most of the song sparrows, and all but a very few of the dickcissels and field, chipping, vesper, lark, Harris, and grasshopper sparrows, are replaced in winter by snowflakes, juncos, longspurs, fox sparrows, white-throated sparrows, and white-crowned sparrows. All these birds have much the same food habits, but they differ in the quantity and kind of seed they eat. Thus, the tree sparrows, or 'winter chippies,' and longspurs feed largely on seeds of grasses, especially those of pigeon-grass, crabgrass, and allied species, while the white-throated sparrow in the Eastern States, Nuttall's sparrow in the Pacific coast region, the snowflake of the northern tier of States, and the white-crowned sparrow, so abundant in the central part of the United States, particularly relish amaranth and lamb's-quarters. The white-throated sparrow is also a great consumer of ragweed, and outranks in this regard every other sparrow except the junco. The song sparrow shows a liking for polygonums, and in the destruction of the weeds of this genus is the most valuable bird whose food habits have thus far been investigated.

During cold weather the native sparrows require an abundance of food for warmth, and it is habitual with them to keep their stomachs and gullets heaping full—so full, in fact, that if a bird be killed and shaken by the feet scores of seeds rattle out on the ground. This habit, coupled with their gregariousness, greatly increases their efficiency.

SUMMARY.

It is hardly to be expected that such seed eaters as sparrows should destroy as great a quantity of insect pests as birds that are entirely insectivorous. When it is found that in the food of the native sparrows such pests average but 25 percent, it is only what might be

expected. Still this percentage, when compared with the percentages found in the cases of some other birds, is no mean showing. The red-winged blackbird's is less than 20 percent, the catbird's but 16 percent, the cowbird's 13 percent, and the crow blackbird's only 10 percent.

But as weed destroyers, the native sparrows are unrivaled. In a garden within two months they will sometimes destroy 90 percent of such weeds as pigeon-grass and ragweed. After they have consumed most of these seeds they turn to those of other weeds, which furnish them with a bountiful supply of food all through the winter and even well into the spring. Weed seed forms more than half of their food for the entire year, and during the colder half of the year it constitutes about four-fifths of the food of many species.

When the food of the native sparrows is divided into the three classes mentioned on page 16, the neutral part proves to be small, not exceeding a third of all that is eaten; the injurious part very small; and the beneficial part much larger than that of most birds, and from five to ten times as great as the injurious part. We may therefore safely conclude that, as a class, these small birds are well worthy of our protection.

SPARROWS IN THE FIELD.

Much individuality is shown by birds in the selection of their particular habitats. Some species, like the meadowlark and the prairie chicken, live out in the open; others, such as the catbird and the brown thrasher, prefer to dwell in close proximity to suitable shelter; and still others, like the bobwhite, are fond of the open, but nevertheless require the presence of cover at no great distance. A similar difference in habitat prevails among the several species of sparrows, which renders them more or less complementary to one another in their work.

Through the kindness of Mr. J. S. Russell, of Boston, I was enabled to make some observations during 1892 on a New England farm near the base of Mount Chocorua, one of the southern peaks of the White Mountains. These investigations were made with a view to ascertaining the character of the localities selected as nesting sites by different species and the extent of territory covered by each in securing food for itself and young; also to learn what ground was covered after the nesting period had passed. The results may be briefly summarized. A chipping sparrow was found nesting in a lilac spray over the farm-house door and feeding in the dooryard, with an occasional foraging trip into a road leading through an adjoining pasture; a field sparrow nested in the briery lower end of this pasture; a song sparrow, in a marshy spot about 30 yards from the field sparrow's nest; a vesper sparrow, in a hayfield above the pasture, feeding there and in the

pasture; and a pair each of white-throated sparrows and juncos in a moist lowland meadow just below the pasture. The last-mentioned birds appeared to come into contact with the cultivated crops of the farm less than any of the others, and seemed less naturally placed than some scores of other white-throats and juncos that nested about 1,000 feet higher up the mountain. When the nesting season was over and all the birds became more gregarious, field and chipping sparrows were observed in the pigeon-grass that had overspread the vegetable garden near the house; both of these species and vesper sparrows along the hayfield fence, with juncos just beyond the fence; and song sparrows, white-throats, and a few white-crowns in the moist meadow. The last three species later (the first week in October) entered the vegetable garden.

In a count of the individuals found within a radius of 5 miles from the farm as a center, made during the seventy-five days from July 18 to September 20, song sparrows were noted 139 times, chipping sparrows 138 times, field sparrows 113 times, vesper sparrows 73 times, white-throats 58 times, and juncos 39 times. Care was taken not to count the same individual twice in a day.

The chief interest in these observations is their comparison with much more extended and thorough studies pursued on a farm at Marshall Hall, Md., which has been frequently visited during the past five or six years. This farm, as has been mentioned, is situated upon the level, alluvial bluff of the Potomac, directly opposite Mount Vernon, Va. On the brink of the bluff stand, at intervals along several hundred yards of sandy road, a farmhouse, a horse barn, a cow barn, and a negro cabin. Mowing land, pasture lots, and fields where corn, wheat, and tobacco are grown, extend back from the river for a third of a mile. Out in the arable land is a storage barn. Between this barn and the river runs a bushy ditch that courses almost parallel to the river for the greater part of its length and then turns to empty into it by means of a swampy timbered outlet beyond the negro cabin.

On these two farms, so different in feature—one beside a Southern river, the other on a slope of a New England mountain—the same characteristics are found to mark the habitats of the various sparrows. In summer, song sparrows live in the swampy outlet of the ditch, all along the beach of the river, and in a wet blind gully cut into the bluff just above the farmhouse, but frequently leave their almost aquatic habitat and ascend to the top of the locust-fringed bluff in order to forage in the road and about the buildings for kinds of food not plentiful along the river shore. Chipping sparrows breed about all the buildings of the farm, but have never been observed on the beach or in the swampy indentations of the shore line. Several nest in a pear orchard hundreds of yards distant from any waterway. Field sparrows rear their young upon poor, worn-out land of the farm,

usually amid the broom sedge and briers of the upland, and at no great distance from cover. Some dwell along the draining ditch previously referred to. The favorite resort, however, seems to be a small clay knoll overrun with dewberries and hemmed in by trees on a part of the bluff 200 yards from the nearest buildings. At the edge of the bluff they are sometimes mingled with song sparrows that come up from the beach. Chipping sparrows are never found with them at this point. Several pairs of grasshopper sparrows have their homes in the hayfield, which extends back from the bluff, and one or two pairs build in an adjoining briery old cornfield. All of them prefer dry, grassy fields devoid of the cover which many other birds find essential. No song or chipping sparrows enter very far into the timothy, and field sparrows that occasionally venture in a little way keep near the ditch. English sparrows breed in the gutters of the house, in an abandoned dovecote, and in holes of trees standing in the dooryard. They feed wherever grain is obtainable.

This rough description of the habitats of the several kinds of sparrows will make clearer a more detailed consideration of the summer food habits.

Song sparrows during the breeding season run along the sandy and pebbly beach of the Potomac and investigate the aquatic vegetation cast up by the water and the logs and other débris left by the tide. Here they secure certain kinds of ground-beetles which live at the water's edge, running spiders of such species as are plentiful on the beach, aquatic snails, dragon-flies, and May-flies, as well as their favorite food, the seeds of the various polygonums, which generally grow in moist places. In the gully above the farmhouse they obtain blackberries, wild cherries, and mulberries. So far as my rather limited observations go, this fruit is picked up from the ground—a method that if habitual justifies a higher economic rating of song sparrows; for during berry time about 10 percent of the food of song sparrows is furnished by cultivated patches of blackberries and raspberries, and if the fruit thus destroyed is entirely or chiefly that lying on the ground little damage is done to the crop.

The song sparrows which breed in the catbriers of the gully beside the house and the honeysuckle-draped shrubbery of the almost perpendicular face of the bluff in front of the house make frequent journeys to the dooryard and vegetable garden. One pair of song sparrows built in a bush in the center of the garden, and were constantly seen in company with chipping sparrows, hopping about on the ground among the beans and cabbages. Song sparrows fed also along the road on the brink of the bluff. In the weedy growth of the roadside which was a few inches high and consisted of cropped grass, a little clover, and many such weeds as chickweed, knotweed, lamb's-quarters, oxalis, sheep sorrel and rib-grass, they picked up weevils and other beetles, and caterpillars, besides some of the lamb's-quar-

ters and knotweed, and in the adjoining field they found the seeds of pigeon-grass, crab-grass, and paspalum. It was a common sight during early summer to see them hunting along the two rows of knotweed in the road, and every now and then scratching in the sand for seeds, which they speedily devoured with apparent relish. One day, after a storm, I noticed a song sparrow searching and picking amid the black débris of vegetable matter left in the road by the water. I examined the débris and found in it several seeds of last season's lamb's-quarters.

Chipping sparrows hunt industriously through the same roadside vegetation, and some that were collected were found to have eaten weevils, grasshoppers, leaf-beetles, knotweed, oxalis, and chickweed. One bird that I watched with a telescope picked off some of the hundreds of midges resting upon a knotweed plant, and subsequently plucked caterpillars, leaf-hoppers, and ants from other plants.

Chipping sparrows, unlike song sparrows, are given to foraging out in plowed fields—a habit which increases their usefulness on the farm. Four of these birds were collected on May 29 (1896) from the middle of a field newly plowed for tobacco. They had eaten largely of timothy seeds, and less freely of weevils, click-beetles, and two kinds of leaf-beetles (*Odontota dorsalis* and *Chætocnema denticulata*). Two years later this field was in hay, and although grasshopper sparrows bred in the high standing grass, chipping sparrows were not seen there until the crop was harvested, when they spent much time hunting in the stubble. On one August day three chipping sparrows were noticed well out in the stubble, darting up into the air and catching winged ants (*Solenopsis molesta*), which floated over the field by millions. These insects have stings, spines, and formic acid, three of the devices supposed to repel birds; yet the three chipping sparrows secured 21 ants in 20 minutes, and several English sparrows and a score of bank swallows were also observed greedily devouring them. Some song sparrows came up from the beach and ran a little way into the hay stubble; and although they were not actually seen feeding on the ants, it seems probable that they also availed themselves of this abundant and easily accessible food supply.

In the pear orchard a score of chipping sparrows were observed during the last week of August (1898) destroying the seeds of an abundant growth of crab-grass that was choking the truck crops among the pear trees. They were also eating the seeds of climbing bindweed, spotted spurge, purslane, and oxalis. The exact method of procuring the crab-grass seeds, still in the milk, was as follows: The birds hopped up to fruiting stalks and, beginning at the tip of one of the spikes, bit and chewed the seeds, gradually moving their beaks along to the base. On finishing one spike they immediately commenced upon another. Usually they did not remove their beaks until the base was reached, though some, especially birds of

the year, would seize a spike by the middle, munch the seeds a few seconds, and then pass to the next. Pigeon-grass was treated in like manner. The seeds of these two grasses are more commonly eaten by sparrows later in the season after they have dropped to the ground.

Twenty or thirty chipping sparrows were observed on June 16 (1898) about a field of ripening wheat that lay back from the river. Some of them had doubtless bred near the field, but some had come from the buildings along the river front. They often flew out into the wheat—100 yards from the fence—to a luxuriant growth of ragweed, and destroyed many beetles (*Systena blanda*), pests that proved very injurious during the next season. Several field sparrows were also noted, but these did not accompany the chipping sparrows into the wheat field, but stayed chiefly among the weeds and briers of an adjoining old cornfield.

Field sparrows showed no striking differences from chipping sparrows in diet, for, although the nesting sites of the two species were quite distinct, the feeding ranges constantly overlapped. One pair with recently fledged young, however, occupied a weedy old tobacco seed-bed among the woods, hundreds of yards from the nearest point at which chipping sparrows occurred. Here the old birds were eating crab-grass and feeding their young on caterpillars and grasshoppers.

On one day early in September a flock of 15 field sparrows was observed moving from point to point beside an osage-orange hedge that extended back from the river several hundred yards. The birds were feeding on crab-grass that grew along the hedge, but every now and then one would spring up into the air and seize a braconid (*Melanobracon*), numbers of which continually flew about amid the herbage of the field. Braconids, often erroneously called ichneumon flies, are of much value earlier in the season owing to their attacks on caterpillars.

Field and chipping sparrows sometimes feed together near water courses. In such case I always found song sparrows feeding with them. During August (1898) the three species were frequently together in a tobacco field beside the negro cabin. This field was so infested with tobacco worms that the crop for that year had already sustained a loss of 50 percent; but none of the sparrows appeared to molest the worms, which perhaps were larger than they could conveniently handle, but fed chiefly on such insects as subsist on the weeds of the tobacco field. As these insects at times forsake the weeds and attack crops, their destruction is of more benefit than injury. Field sparrows were found feeding in the cornfields from the time the corn tasseled until it was harvested. They were also partial to briery old cornfields, where they were often associated with grasshopper sparrows. Chipping sparrows fed in cornfields, old or growing, only when they were near buildings, and song sparrows never entered them except in the vicinity of a water course.

Grasshopper sparrows, the most insectivorous of all eastern sparrows, are birds of the open fields, just as many of the other species are birds of the hedgerows. One or two pairs chose for their breeding grounds one of the old cornfields just mentioned and raised their families amid the brier tangles that claimed the field. No notes were made of the feeding habits of these. Several pairs, however, that nested in the adjoining hayfield were carefully studied. Among the different insects fed to their young were grasshoppers of the genera *Hippiscus*, *Dissosteira*, *Melanoplus*, *Scudderia*, and *Xiphidium;* cutworms, army worms, and various related larvæ; such bugs as *Alydus pilosulus* and *Hymenarcys nervosa;* and various spiders, including *Oxyopes salticus*. The parent birds ate spiders and grasshoppers of the same kinds, with beetles of the genera *Systena*, *Sitones*, and *Ataenius*, and such bugs as *Alydus*, *Corizus*, and *Trichopepla semivittata*.

The record of the English sparrows at the Marshall Hall farm shows nothing to their credit. They have reduced the wrens in number, completely crowded out the bluebirds, and have stolen many of the nesting burrows in the exposed face of the bluff properly belonging to the bank swallows that daily come to the farm to circle over the fields for insects. Their slight value as insect destroyers could very profitably be dispensed with if the services of the indigenous species which they have driven away could be restored. Their number seems to vary from 30 to 200. Each night they roost with the chickens among some cedar trees by the house, and in the daytime usually feed with the chickens and hogs or glean grain around the various buildings of the farm, particularly the cornerib. Such food as they secure in the field is usually grain, but very rarely weed seed. They damage the ripening oat and wheat crops, partly by pilfering the grain, but more by breaking down the stalks, and join the crows in their attacks on corn in the milk, though in this case they are able to do but little harm. Their habits contrast strikingly with those of the several native species frequenting the farm.

The summer observations on the two farms, especially on that at Marshall Hall, give interesting and suggestive data concerning the relation of the native sparrows to agriculture. They show that the nesting habitats of the different species are so distinct and varied as to be complementary to one another. Chipping sparrows nest around the buildings, field sparrows in worn-out fields and briery pastures, vesper and grasshopper sparrows in level hayfields, and song sparrows in gullies and moist meadows and along waterways, while juncos and white-throats have their nesting places in the high, lonely mountain clearings of the north. The ranges of the various species become less distinct after breeding time is over; but, though they blend and overlap, each species seems to continue its own peculiar work. During this period chipping sparrows cover a wide range—garden,

orchard, roadside, and far out in ploughed land and stubble-fields; song sparrows frequent gully, thicket, bluff, and river shore, and make forays into garden and field; field sparrows are found in waste land and cornfield, and at times in garden and hayfield, and vesper and grasshopper sparrows far afield in the midst of grass and other crops. Each renders important service, and all together, by supplementing one another, are of very great value to the farmer.

In their regular feeding habits sparrows and other birds are constantly engaged in keeping the flood of insect life within bounds, each, as here shown, having its own separate field of work; but when, as sometimes happens, any particular kind of insect overflows its usual limits and threatens to disturb the normal distribution, all the birds often seem to abandon temporarily their accustomed fields and unite in overcoming the invasion. Two instances of this kind came under observation on the Marshall Hall farm. In 1895 the locust leaf-mining beetles (*Odontota dorsalis*) became overabundant and turned the beautiful green of the locusts fringing the bluff into an unsightly brown. All the birds, including the sparrows, ate these beetles freely and constantly, and largely aided, by their united attack, in reducing the beetles in number to such an extent that they have not appeared subsequently in sufficient force to repeat the damage. Again, during May, 1899, the May-flies, which emerged from the river, became a plague, alighting upon the farm buildings and literally covering them, frightening the horses, annoying the workmen, and infesting the farmhouse in such swarms that it was well-nigh uninhabitable. Practically all the birds of the farm fed on them, and in a large measure reared their young upon them, and by this means reduced them to their normal level. May-flies do not ordinarily become obnoxiously abundant, but when they do even their function in furnishing subsistence to valuable food fishes does not save them from being ranked as pests, the destruction of which is beneficial.

In order to study the feeding habits of sparrows during cool weather, the Marshall Hall farm was visited in the middle of November, 1899, when heavy frosts whitened the ground every morning. The chipping sparrows and grasshopper sparrows had left for warmer latitudes, but in their places were throngs of tree sparrows, white-throated sparrows, juncos, and fox sparrows, which had come down from the north. A few savanna sparrows were also noted. Field sparrows were present in fully as large numbers as they had been during the breeding season, while song sparrows appeared even more abundant. The sparrow family, as a whole, was several times more numerous than it had been during the summer.

The several species were extremely shy, and nearly all kept very close to cover, in marked contrast with their comparative indifference during the breeding season. Hedgerows or other shelter seemed usually essential to their presence, and but for the bushy ditch and

osage-orange hedge it is doubtful if most of the species would have been found at all in the largest fields of the farm. The juncos and field sparrows showed somewhat less of this dependence, the latter being sometimes observed feeding 50 to 75 yards from cover; and the few savanna sparrows observed, as is usual with that species, ranged freely over the broadest fields. The reason for the rule of keeping close to shrubbery of some kind became evident one morning, when a flock of 30 sparrows that was feeding a few paces from the cover of the brink of the bluff suddenly rose and scurried to the bushes just in time to escape a sharp-shinned hawk, which had noiselessly swooped down on them. They were so often menaced by this enemy and the closely allied Cooper's hawk that they did not dare to seek their food far from protecting vegetation.

The different species of sparrows appeared to mix indiscriminately, but close inspection disclosed flocks within flocks. The song sparrows and white-throated sparrows mingled freely, but the juncos and the fox sparrows, and to a lesser degree the field and tree sparrows, were generally grouped separately. These flocks, however, often fed in company with the other kinds.

The ranges of the different species on the farm were, therefore, not so distinct as they were in the case of breeding birds; but certain preferences in the selection of feeding grounds were shown by the various species. A score of field sparrows with decidedly clannish instincts were always to be found upon the high clay knoll which had formed a nesting site for this species, and there was a smaller flock along the ditch in which field sparrows had also bred during the summer. Tree sparrows habitually resorted to this same ditch at a point somewhat nearer its outlet. The land occupied by these two species was poor and supported a rank growth of broom sedge. White-throated sparrows and song sparrows, although found to some extent along the ditch, usually frequented the tangled underbrush of the narrow strip of trees fringing the bluff. Juncos often associated with these two species, and at times flew over and fed in company with one or the other of the two flocks of field sparrows. They exhibited a peculiar habit of using a big cedar tree in the middle of an old cornfield, just as the other sparrows resorted to a hedgerow for protection. Vesper sparrows were observed destroying many weed seeds in the open fields.

Thus field sparrows occupied their summer quarters, and tree sparrows chose similar locations, and showed a resemblance to field sparrows in their liking for broom-sedge fields; song sparrows inhabited much the same places as in summer; juncos habitually fed far afield, while, strange to say, white-throated sparrows, the summer associates of the juncos in the New England mountain clearings, were found in a different habitat and in company with another species, the song sparrows.

Some interesting notes on the feeding habits of sparrows were obtained through these autumnal visits. Out in a cornfield, farther from cover than many of the birds would venture, a flock of juncos was found picking from the ground the fallen seeds of the pigeon-grass which had overspread the field. Beside the road along the bluff, where there was a fringe of Virginia wild rye (*Elymus virginicus*) and tall redtop (*Sieglingia sesleroides*), juncos were also observed eating the seeds of these grasses in company with white-throated and song sparrows. They picked up most of the seeds from the ground, but took a few from the stalk. Where the seeds were covered by fallen leaves they scratched the leaves away, unlike crows, which use their large beaks in such cases. The same three species were grouped together in a wheat-stubble field which had grown up to ragweed, where they were securing the ragweed akenes that had dropped to the ground. These birds were watched with a powerful field glass and were seen to crack the akenes, drop the dry shells, and swallow the meaty part, a process that clearly precluded any subsequent germination. On the bare knoll already mentioned was a growth of red-sheathed rush grass (*Sporobolus vaginæflorus*) and poverty grass (*Aristida*), and here field and tree sparrows were scattered about the ground feeding on the fallen seeds of these grasses.

One or two of the fields were overgrown with broom sedge, the seed-buoying plumes of which, when lighted up by the low sun, gave a frost-like brilliancy to the reddish straw-colored mass beneath. Field sparrows and tree sparrows were also found here, and as they swayed on the tops of the stalks, taking seed after seed, they would disengage the light plumes, which would float away empty. Sometimes the birds on alighting on the plants would bend them to the ground and would hold them down with their feet as they picked out the seeds, but not often would they otherwise feed from the ground.

Out in the middles of the fields of a dozen acres or more a few savanna sparrows were observed, which, with ten or twelve quail and fifty or sixty meadowlarks, were busily reducing the weed harvest. Vesper sparrows were sometimes associated with them and seemed equally independent of shelter. Apart from these there were few that fed far from cover, the juncos in the cornfield and the field and tree sparrows in the broom-sedge growth, which sometimes were found 50 to 75 yards afield, forming practically the only exceptions.

The white-throated, fox, and song sparrows undoubtedly fed on wild fruits, but it was very difficult to observe them in the act. A flock composed of these species was observed in a tangle of vines that grew along the bluff. Several white-throated sparrows were noted ascending high up into a butternut tree entwined with woodbine and wild grape and feeding in company with a flock of cedar birds on the fruits of these two vines. Another white-throat was seen to eat a pokeberry, and a song sparrow a berry from a woodbine which hung

so low as almost to touch the ground. That several species of sparrows feed on berry seeds has been shown by stomach examination, and this habit may account in a measure for the birds' spending much of the time among such tangled thickets of fruiting plants.

A heavy fall of snow on February 17, 1900, made possible the study of the feeding habits of sparrows under typical winter conditions. Unfortunately it was not feasible to visit the farm on which observations had thus far been made, but a neighboring farm on the same bluff afforded ample opportunity for investigations. Here much of the land is given up to market gardens and orchards, with a consequent superfluity of weeds, which, with the admirable cover afforded by two slightly timbered bushy brooks that converge to enter the river in a swampy outlet, furnishes a good locality for sparrows.

Between the two brooks, in a potato field grown up to ragweed, ama ranth, and lamb's-quarters, a score of tree sparrows, song sparrows, and juncos were busily feeding. Most of the ragweed akenes lay buried under a foot of snow, very few clinging to the stalks. An abundance of the seeds of lamb's-quarters and amaranth was, however, available. The birds seemed to prefer the ragweed, but they also ate large quantities of the others. While some fed from the tips of sprays, others hopped about on the snow and picked from the lower branches. So thick were bird tracks in the snow in one part of the field that in a space 50 yards square it would have been difficult to find many places a square yard in extent that were untracked by the tiny feet. Mouse tracks were also noticed, but these were so few that the extensive destruction of seeds shown by the amount of chaffy débris on the snow was evidently due almost entirely to the sparrows.

The tree sparrows were the most habitual stalk feeders. They pitched down here and there in flocks to feed on the seeds of the straw-colored broom sedge (*Andropogon virginicus*), and then would journey on, sometimes half a mile, till they came to another patch of the same grass. They often picked from every stalk before passing on to other feeding grounds. Frequently two birds would be seen feeding from a single stalk, while a third would be hopping in the snow below searching for seeds shaken down or accidently dropped. The snow was blowing in clouds across the fields and these northern birds seemed more at home in their wintry surroundings than any of the other sparrows. This adaptability to snowy conditions makes them extremely useful in supplementing the work of other birds which are not habitually stalk feeders, and which, therefore, must be less efficient weed-seed consumers when the ground is covered with snow.

It was expected that the snow would force all the sparrows to stalk feeding, but such was not the case. Most of them fed, in company with cardinals, doves, and meadowlarks on the bare bluff, which was swept clear of snow by a gale that blew across the Potomac at a rate of from 20 to 40 miles an hour, and where their feeding ground was a

closely cropped pasture of Bermuda grass with comparatively few seeds. Here they gathered such sustenance as they could secure, keeping their heads to the blast and looking like so many trout heading upstream. They apparently preferred to battle with these adverse conditions rather than feed from weed stalks, which offered plenty of food in sheltered situations. They seemed to have no regard for cover. Out in the pasture they hopped about ravenously eating seed after seed, hunger having apparently driven away all fear. More than 200 were thus engaged, chiefly juncos and tree sparrows, but with song sparrows, white-throats, and field sparrows also present. They covered the pasture completely, and by consuming an enormous quantity of the seeds of the Bermuda grass, or wire-grass as it is locally known, prevented in a measure the blowing of the seeds to truck land, where this grass is the worst weed of the farm and entails an annual expense of $200 to the owner.

During the two following days the wind, together with some melting, caused bare spots to appear in the snow on the truck land and orchards beyond the pasture. The sparrows straightway left the wire-grass for the crab-grass, ragweed, and lamb's-quarters that abounded in the truck land and orchards. Ground feeding proved to be the habitual method, although the white-throats and a song sparrow were seen feeding on ragweed stalks, and a junco and a tree sparrow on those of lamb's-quarters. Most of the sparrows fed on crab-grass wherever it was exposed, and they flocked so thickly in it that one might have collected several with a single discharge of a shotgun. A flock of 100 goldfinches fed with the sparrows. The service rendered by the 300 birds was doubtless of considerable value; when a large number of birds thus work together within a limited area the good is evident.

In addition to the main body of sparrows, there were certain more or less isolated little troops of individuals about various parts of the farm. On some poor land back from the river there were about 20 field sparrows that fed from the exposed culms of broom sedge. During the snowy weather no sparrows except tree sparrows were seen with them, but afterwards they were joined by juncos and song sparrows. Song sparrows, during the coldest and most blustering days, were seen scatteringly all along the sandy beach of the Potomac between the ice sludge and the foot of the river bluff, but almost entirely deserted the bushy brooks and fence rows, where the snow was from 2 to 3 feet deep. Many repaired to grain barns, where they obtained weed seeds, feeding, like the birds in the Bermuda-grass pasture, in the worst wind-swept places and with their heads to the blast. Juncos occasionally associated with these song sparrows and often took refuge with them in the barns. Several song sparrows were found foraging with a flock of 50 English sparrows in the cow yard of the stock barn and about the hog pen. One of these and all the English sparrows went into various parts of the barn in search of grain.

It will thus be seen that snowy conditions alter somewhat the usual characteristics of sparrows' food habits. The native sparrows traveled farther afield and consumed the less palatable weed seed, which would not ordinarily be eaten in quantity, and even the English sparrows were once observed feeding on weed seed out in the open.

A series of observations was made in a most favorable locality in the District of Columbia from the last of November, 1899, to the end of February, 1900. The topography of the place was studied, and notes were made of the exact distribution of the sparrows found there, the actual amounts of the various kinds of weed seed destroyed, and details relating to the dissemination of seeds by the birds. The place comprises about 10 acres, traversed by a shrubby brook and almost surrounded by deciduous trees. On one side of the brook the land slopes very gently upward from the water, while on the other there is a steep bank of varying degrees of declivity. Where the slope is steepest, so abrupt in fact that cultivation has proved impracticable, as is attested by a grove of venerable beeches, an almost perpendicular curving bank marks an old course of the brook when it swung some 50 yards from its present channel. On the other side, a little farther down, a bowing curve marks another part of the abandoned channel. The bank here is abrupt on the side worn by the stream and on the other slopes gently downward to a cultivated field beyond, the level of which has been lowered by the washing away of the soil by rains. On the brink of the bank is a row of cedar trees. At the time of the investigation the land between the two beds of the stream as well as that beyond the bank had been in corn. The vegetation of the brook, its two abandoned curves, and a briery tributary near the upstream end of the tract formed the cover and to a considerable extent the feeding grounds of from 100 to 200 native sparrows. The food supply of this cover consisted of giant ragweed, spreading panicum, and climbing false buckwheat. The last was most abundant along the brook, where it climbed over the briers and shrubs, even ascending and festooning some of the trees. The giant ragweed, higher than a man's head, formed a forest of stalks between the brook and the old channel on the steep side, and was common at the mouth of the tributary. Spreading panicum grew on the concave declivitous faces of the banks and in the tributary. It was less abundant at the mouth of the tributary where it was mixed with the giant ragweed. The other feeding grounds comprised the weedy land between the former and present channels, to a slight extent the gentle slope which, except along the stream, had only a scanty growth of weeds, and finally and of great importance, the steep slope on which wheat had been grown and which bristled with ragweed, and a vegetable garden on more level ground above, where was a luxuriant crop of crab-grass, pigeon-grass, and amaranth. These several situations naturally formed almost ideal resorts for the native sparrows.

The individuality of the habits of each of the several species, though not so marked as on the Marshall Hall farm, was nevertheless sufficiently pronounced to merit passing consideration. Tree sparrows were usually too few and too shy for observation, and, with one exception, field sparrows were found only in little groups of not more than half a dozen individuals. The lack of these two species may be correlated with the absence of worn-out land and the broom sedge with which they appear to be so intimately associated at Marshall Hall.

The song sparrows and white-throated sparrows taken together aggregated 50 or 100. Sometimes one species was the more abundant and sometimes the other. They seemed to associate together constantly, as on the Marshall Hall farm. This was especially noticeable when they were feeding along the brook on the seeds of climbing false buckwheat, of which they are much more fond than are other sparrows. As has already been shown, white-throated sparrows destroy much ragweed, while song sparrows are very partial to grass seed. Hence it would frequently occur that on leaving the false buckwheat and ascending the hill the white-throated sparrows took to the ragweed on the slope while the song sparrows would feed on the crab-grass and pigeon-grass in the garden beyond.

The fox sparrow, unlike these two species, resembled the cardinal in its habit of staying close to cover and not feeding any distance afield.

The junco, on the contrary, surpassed all the other sparrows in feeding in the open. Even though its food, as revealed by the examination of stomachs, shows a comparatively large percentage of grass seed, which is usually indicative of less effectiveness as a weed destroyer, yet because of its habit of feeding afield, it is far more valuable than many of the cover-loving species which take less grass seed. Not only did the juncos feed out in the open themselves, but they encouraged other species to follow them into the middles of the ragweed field and vegetable garden, and even quite a distance out into a piece of exposed corn stubble which supported only pigeon-grass and crab-grass. They used cedar trees for cover, as at Marshall Hall, and did not seem dependent on bushes, like other sparrows. Often the flock, numbering over 100 individuals, on being alarmed would fly to an open beech wood and ascend to the tops of the tallest trees, whence they would fly several hundred yards to some open field. Song sparrows under similar conditions never leave their bushy covers to ascend to the tops of trees.

The weed seed destruction appeared much more effective than at Marshall Hall, because the feeding ranges of the birds practically included the whole of each of the several fields; even those birds usually most restricted to cover were often found in the centers of fields. The reason for this more fortunate condition seemed twofold.

In the first place, they seemed to be comparatively free from the attacks of hawks, and in the second, each of the several fields was small, containing but two or three acres, and all together amounting in acreage to hardly a single field of the Marshall Hall farm, hence the birds were never far from protecting cover.

The ground-feeding habit of sparrows was sometimes brought into sharp contrast with the feeding methods of other birds. Thus on December 10 (1899) throughout the dense ragweed of the steep slope, there were about a hundred white-throated and song sparrows busily picking up the fallen akenes, while a dozen purple finches and 2 chickadees were plucking seeds from the stalks. Again on February 3 (1900) in this same field about 50 juncos, a dozen song sparrows, and several field sparrows were feeding entirely from the ground, while a score of goldfinches hung from the tops of the ragweed, feeding entirely from the stalks. Along the tributary of the brook several purple finches were perched on the climbing false buckwheat vines feeding on the seeds still on the vines, while tree sparrows, juncos, field sparrows, white-throated sparrows, song sparrows, and fox sparrows hopped about on the ground below them, searching for seeds that had fallen. Between this tributary and the woods, on ground weedy with crab-grass and partly covered by fallen leaves, a flock of about 150 sparrows, including all the above species save the fox sparrow, were busily feeding on the scattered seeds. The song sparrow, white-throats, and juncos scratched so busily among the fallen leaves that they kept up a continuous dry crackling sound, audible for 50 yards. The differences noted on these two dates were commonly met with throughout the winter, affording abundant evidence of the manner in which the ground-feeding sparrows supplement the work of stalk-feeding species.

But although ground feeding is the rule with sparrows, it is not, as has already been shown, an invariable one. A notable exception was the stalk feeding of field and tree sparrows in the broom sedge of the Marshall Hall farm, which has been mentioned. To some extent the same species showed the same characteristics on the farm under consideration. Field sparrows were observed in several instances feeding entirely from the culms of the spreading panicum. The several other species of sparrows, except tree sparrows, which fed on this grass, did not appear to be able to secure the seeds in this way, but waited until they had been shaken out one or two at a time from the inclosing sheaths. Song sparrows, juncos, and white-throated sparrows were occasionally observed taking seeds from the stalks of other plants. In four instances juncos were seen in the tops of tall amaranth plants picking out a few seeds. A song sparrow was also noted feeding from amaranth stalks, and others were noted feeding from the stalks of ragweed, dock, and lamb's-quarters. A white-throated sparrow in a single instance was observed plucking a seed

from a false buckwheat vine. But these were isolated instances, rare exceptions to the general rule of ground feeding.

It should be stated, however, that there was snow on the ground during only one of the visits, and then it was barely an inch deep, while there was a big bare place along the tributary where sparrows spent much of their time feeding on crab-grass and pigeon-grass. Had the snow been a foot in depth all of this food supply and much of the ragweed would have been rendered unavailable, in which case it seems probable that the birds would, for a time at least, have been obliged to take ragweed akenes from the plants, and perhaps, like the snowflake (see p. 53), to resort to the seeds of amaranth and lamb's-quarters, which appeared to be less palatable to them.

The snow afforded very useful records of the actions of the sparrows. A few footprints far out in the middle of the ragweed field and many in the weedy garden above showed where the birds had been feeding. In many places much chaffy débris gave additional evidence. It appeared more frequently under plants of lamb's-quarters than under those of the more abundant amaranth, showing the birds' preference for the former species; and in most instances bending plants just grazing the ground had been resorted to, while sometimes the birds had apparently been feeding from the stalks. Similar débris, consisting of parts of flowers and broken shells of akenes, were found under many ragweed plants. It might be supposed that weed seed destruction by mice would be of more value than that by sparrows, but the records left in the snow did not justify any such conclusion. Not only were mice tracks extremely few compared with those of the birds, but no evidence appeared of the eating of weed seeds by the few mice that had been in the fields. One track that I carefully inspected passed directly through the ragweed in the wheat stubble, but nowhere could I find any indications that the mouse had eaten seeds of any kind.

Some notes were made of the destruction of ragweed akenes. In the snow beneath a ragweed 3½ feet high a song sparrow was feeding. Subsequent examination showed about 50 imprints of its feet, 3 whole akenes, and the broken pieces of the shells of about 20 more, together with some of the débris of floral parts. On another day a hundred juncos, white-throats, and song sparrows had been feeding busily for half an hour in a patch of ragweed, and a few minutes' careful inspection of the ground disclosed only 6 whole akenes among a hundred empty half akenes. At another time a dozen fox sparrows were busily scratching on the ground under a patch of giant ragweed and picking up the large akenes. Here I found a large number of empty entire akenes, at the smaller end of each of which was a rent through which the meaty seed had probably been squeezed by pressure from the birds' beaks. This method of manipulation seems to account for the

fact that giant ragweed seeds are rarely met with in sparrows' stomachs in a condition allowing identification.

The grain of spreading panicum, being inclosed in sheaths, rattles out on the ground a little at a time throughout the winter, and thus affords several species of sparrows a constant supply of food. Under some of these plants where a song sparrow had been hopping about were found 12 grains, 6 of which proved to be empty, and under others where a junco had been picking from the ground 5 out of 6 grains found were empty. Sparrows appear to make a practice of removing the outer glumes of these grains before swallowing them, while those of the closely related crab-grass they seldom, if ever, remove.

Climbing false buckwheat rains down multitudes of its seeds, which furnish an abundant and accessible supply of food. In one sandy place thick with birds' tracks 52 of the seeds were found within a radius of 2 feet, and all but 5 were empty. Seeds of this plant are shiny black and look like miniature beechnuts. In some cases one of the three sides of the seed had been cut away, while in a much greater number one of the three edges had been slit so as to leave the empty seed shell entire and apparently uninjured.

Part of the investigation on this farm was directed to the question of the dissemination of weed seeds by sparrows. One hundred and fifty bird droppings were collected on each side of the brook, in the ragweed field and in the weedy garden above. Examination of these revealed but 7 uninjured seeds, one of crab-grass and 6 of amaranth, certainly a very insignificant proportion of the number consumed. And it is not unlikely that many of those thus voided uninjured are afterwards taken a second time. Most of the dung consisted of the pulverized remains of seeds, among which the most conspicuous were small fragments of the akenes of ragweed. The finely comminuted fragments of grass seeds were also very abundant. Among these crab-grass occurred often, but the remains of pigeon-grass and spreading panicum were positively identified in only a few instances, probably because these two seeds are usually hulled before they are swallowed (see p. 49). Amaranth and lamb's-quarters were easily recognized by the characteristic texture of the coats of their seeds, and in one instance by the empty half shells of the seed. Bits of the shiny seeds of climbing false buckwheat frequently appeared in the dung. The seeds of sedge and oxalis were comparatively rare.

Winter observations on the District of Columbia farm brought out several points which it is to be hoped may prove to be general. Under favorable conditions the entire farm was worked over thoroughly, even at a season when birds require more or less accessible cover for protection. The sparrows took their food chiefly from the ground, in contrast to other species, which they thus supplement. They appeared to have manipulated a large portion of the seeds left

among their pickings in such a way as to prevent germination, and the examination of their droppings furnished good evidence that they do not, as a rule, disperse weeds by such means.

The feeding habits of several abundant and important species of sparrows that have not come under direct observation may be briefly considered in comparison with those of the species found on the three farms visited. The lark sparrow and dickcissel resemble the grasshopper sparrow and vesper sparrow both in their large consumption of insect pests and in the fact that their feeding ranges comprise open areas of cultivated land. The dickcissel, more than the lark sparrow, is a bird of the vast open, treeless tracts, and in the fertile agricultural districts of this character in the central part of the United States appears to be more valuable, both as an insect consumer and as a weed destroyer, than species that stay close to cover. Prof. F. E. L. Beal has observed a flock of snowflakes picking the akenes from ragweed plants at a time when the ground was covered with snow. He also has seen them standing in the snow and stretching on tiptoe for the seeds in spikes of pigeon-grass. The Lapland longspur sometimes feeds out in ploughed land in company with shore larks. It feeds mainly from the ground, rarely, if ever, from the stalk, as the snowflake often does. The wide-ranging habits of all these birds increase their value and make them at least the equals in effectiveness of other sparrows that destroy a greater percentage of weed seed but are curtailed in their usefulness by the fact that their feeding ranges are limited to the immediate vicinity of protecting bushes.

SPARROWS IN CAPTIVITY.

During the spring of 1898 a series of feeding experiments was carried out with a song sparrow, a junco, and a white-throated sparrow. The birds were kept supplied with canary seed and offered different kinds of insects in order to ascertain their likes and dislikes and, if possible, correlate the results with those derived from the examination of the contents of stomachs. May-beetles (*Chalepus*) were frequently offered, but were refused in every case save one. In this exceptional instance the sparrows were very hungry, and the song sparrow attacked the hard-shelled insect and after pecking at it for ten minutes succeeded in breaking it open so that the soft parts could be easily obtained. Then all three sparrows fought for a share of these tidbits. The difficulty of manipulating May-beetles, which form an important part of the insect food of such large birds as blackbirds and crows, seems to explain their absence from the contents of the thousands of sparrow stomachs examined in these investigations.

A number of the experiments were designed to test the efficacy of protective coloration of insects against the attacks of birds. Several admirably protected grasshoppers (*Eucoptolophus sordidus*), which were found with the greatest difficulty on fallen oak leaves, were

replaced on oak leaves, with which they blended perfectly, and offered to the birds. All three sparrows immediately pounced upon the grasshoppers and greedily devoured them. A dozen experiments were tried with the song sparrow to test the efficacy of the protective coloration of weevils. A weevil (*Sitones hispidulus*) sunk almost beneath sand of its own color was always instantly spied out. The results of these experiments, together with the fact that protectively colored weevils and grasshoppers form an important part of the contents of stomachs examined, indicates that sparrows are not baffled by such devices.

Protection by means of the ejection of an offensive fluid seems to be more effective. Blister-beetles (*Epicauta*), which possess an irritating secretion, were repeatedly refused by the three sparrows. Disagreeable secretions when coupled with showy or warning coloration were found, in a number of cases, to repel the attacks of the sparrows. A gaudy orange and black harlequin cabbage bug (*Murgantia histrionica*) was offered to the birds. The junco and song sparrow refused it, but the white-throated sparrow seized it and after some preliminary pecking ate it piecemeal. Two other injurious insects, the three-lined flea beetle (*Lema trilineata*) and the twelve-spotted cucumber beetle (*Diabrotica 12-punctata*), which are warningly colored beetles with pungent secretions, were placed in the cage, but the sparrows, though exceedingly hungry, refused them. The failure of the birds to destroy these pests is in part offset by the fact that they do not prey on the useful ladybird beetles of the family Coccinellidæ, which are also both warningly colored and ill flavored. Two species of these insects (*Adalia bipunctata* and *Hippodamia maculata*) were offered to the birds a dozen times, but were always allowed to crawl out of the cage unmolested. The results of these experiments coincided with the data accruing from the examination of the contents of stomachs in the laboratory.

The frequency with which the smaller and less useful forms of ground-beetles (Carabidæ) are met with in examination of sparrow stomachs suggested the carrying out of some experiments with these insects. Carabidæ emit volatile irritating fluids which would naturally be expected to render them immune from the attacks of birds. Just how effective this protective device actually is will appear from the account of these experiments.

Two specimens of *Amara impunctricollis*, a carabid about one-third of an inch long, were placed in the cage wherein were the three sparrows. The white-throated sparrow instantly seized one of these beetles and the song sparrow the other, while the junco was obliged to content itself with pieces dropped by its mates as they hurriedly ate the tidbits. Before any further test could be made the junco and white-throated sparrows were, unfortunately, accidentally killed; the series of experiments was continued, however, with the song

sparrow. This same species and two others, *Anisodactylus rusticus* and *Pterostichus sayi*, each about a half inch in length, were repeatedly offered to the song sparrow and eaten with avidity. These three species, though possessing the pungent secretion, are not so offensive as many others, hence the strength of the dose was increased, and two carabids of disgusting odor, and about equal in size, *Nebria pallipes* and *Platynus* sp., were placed in the cage. They were eaten with relish. Next a smaller carabid, *Agonoderus pallipes*, was tried. The song sparrow proved to be so fond of this species that he ate fifteen within three minutes. In order to test the strength of the fluid emitted by these beetles, I placed the tip of the abdomen of one of them against my tongue. The resulting sensation was a sour taste, followed by an acute burning which lasted for ten minutes.

A few experiments were then made with the larger, more beneficial beetles. In three instances *Harpalus pennsylvanicus* was offered to the song sparrow, and in one case it was eaten, but with no apparent relish. The fact that this beetle could be eaten at all, and without producing any ill effects, seemed strange when it was recalled that once when one was accidentally mashed against my neck the spot was so severely blistered that the soreness lasted for three days.

The sparrow's limit in the line of such hot food was found when another carabid (*Chlænius æstivus*) was placed in the cage. He seized it immediately, bit it several times, and then swallowed it. In an instant he showed distress, lowered his beak, and attempted vomiting. For several seconds the muscles of his throat worked convulsively with a swallowing motion, then he made a vigorous attempt, which lasted for a minute, to disgorge the beetle. He next flew spasmodically about the cage, every now and then whetting his bill against the wires. At the end of five minutes he suffered most acutely and stood wabbling from side to side with his mouth wide open and the whole throat rapidly pulsating. At the end of ten minutes it seemed death must ensue, but in ten minutes more he was decidedly better, and in an hour had completely recovered. Several days later I put another in the cage. The song sparrow instantly seized it, but, quickly finding out his mistake, hastily dropped it, shaking his head violently and scurrying to the opposite side of the cage. This beetle and other larger useful species seem from these experiments to be safe from the attacks of sparrows, although they are preyed on by many species of larger birds.

Quite a number of miscellaneous experiments were carried out with the song sparrow. Skin-beetles (*Trox* sp.), which derive their popular name from their occurrence on hides in tanyards, and bark-beetles (*Trogosita cærulea*), which inhabit the bark of dead trees, were eaten with apparent relish. A long-horned beetle (*Neoclytus erythrocephalus*), which is supposed to mimic a wasp, was offered, and was eaten without hesitation. A stingless parasitic wasp (*Oplion bilineata*),

placed in the cage met with a similar fate. Stinging insects were not given the song sparrow, but some English sparrows to which they were offered refused to touch them; which seems to indicate that sparrows are able to distinguish between stinging and stingless insects that resemble each other closely. Spiders were eaten by the song sparrow with a relish that helped to explain the frequency with which they are found during stomach examinations. A lace-wing fly, an insect of the most nauseating odor, was also eagerly devoured. Stink-bugs of the genera *Brochymena* and *Euschistus* were refused; but smaller bugs of the families Reduviidæ and Lygæidæ, though strong scented, proved to be exceedingly palatable; and another ill-smelling bug, the common water-strider (*Hydrotrechus* sp.), was eaten without hesitation. Small brown species of leaf-hoppers and a green form (*Diedrocephala*) were offered to the song sparrow and were quickly snapped up, showing that some device other than ill flavor probably protects them ordinarily, since leaf-hoppers, though often exceedingly abundant where sparrows occur, seldom, if ever, form any significant part of the food.

Several experiments were made with Lepidoptera. A salt-marsh-caterpillar moth (*Leucarctia acræa*), a white and yellow insect warningly colored and possessing a powerful odor, was given to the song sparrow, but was refused. Then a yellow swallow-tail butterfly (*Papilio turnus*), also a warningly colored insect, but not having a rank smell, was liberated in the cage. It flew against the sparrow, frightening him badly; but in five minutes the bird had recovered his courage, and, giving chase to the butterfly, captured it, after several minutes of lively fluttering, and finally succeeded in killing it and eating some of the viscera. If the chase had occurred out of doors, the butterfly would have had no difficulty in getting away. Medium-sized brown millers (Noctuidæ) were eaten with great relish, despite the fact that they were seldom found during stomach examinations, which suggests the possibility of their being overlooked because of the difficulty of recognizing their remains among the comminuted contents of stomachs. It is not improbable that these insects are frequently eaten by some species of sparrows.

Some experiments in feeding the song sparrow with different kinds of seeds were attempted, but he did not lend himself with any degree of enthusiasm to this line of work. Lamb's-quarters, amaranth, and polygonums were frequently placed in the cage, but only starvation could bring him to eat any of them, probably because he had been supplied too long with canary seed, which seemed to suit his palate. Experiments with dandelion and amaranth seeds have already been referred to (see pp. 22 and 26). The seeds of chickweed and pigeon-grass were eaten with great relish. It was interesting to note the way in which the bird hunted for food of this kind. He searched about the bottom of the cage, sometimes hopping, sometimes walking, and when

he had secured all the uncovered seeds, he scratched in the sand for the buried ones. When thus engaged he would give a quick jump into the air, swinging his feet forward and then backward, scratching the ground with both feet at once, and apparently with motionless wings.

During January and February, 1900, a series of experiments was carried out to ascertain how far sparrows are responsible for the dissemination of the seeds upon which they subsist. The only birds available for these experiments were seven English sparrows, but the conclusions reached are, in a measure, applicable to all sparrows. The birds were fed seeds of different weeds, and all their droppings were examined to ascertain the condition in which the seeds were voided. The seeds of climbing false buckwheat and ragweed were found to be thoroughly pulverized, although quite a number of small fragments of the black, shiny seed coats of the former were found in the droppings. This result was expected, since the birds crack these seeds before swallowing them. The seeds of lamb's-quarters and amaranth were next tried. These, because of their small size and hard structure, it was supposed would be swallowed whole and would partially escape destruction in their passage through the birds' digestive tracts. But such proved not to be the case. The birds cracked them as they had the others. Halves of seed shells were found in the seed cup, and many broken smaller pieces; and the droppings of the birds showed no whole seeds, although some few empty split seeds with the two half shells clinging together were found. Usually only the finely pulverized dust of the seed coats was found in the fæces. When the sparrows were not under experimentation they were fed chiefly on millet, the grain of which is inclosed by two corrugated siliceous glumes. These were similarly removed by the birds. No whole seeds were found in the dung, and only an occasional small piece of one of the glumes. The closely related seeds of pigeon-grass (*Chætocloa viridis*) are inclosed by much stronger glumes, but when these were fed to the birds the cracking of the grain and the removing of the glumes appeared to be just as complete as in the case of the millet, and seemed as certainly to preclude any possibility of subsequent germination.

Some experiments were made with the seeds of crab-grass (*Panicum sanguinale*). A well-known firm of seedsmen suggested to the Department the probability that the English sparrow was responsible for the occurrence of crab-grass in lawns and golf links sown with pure seed of the finest brand. Much complaint was received from buyers of lawn-grass seed because, after the seed was planted and the turf well established, crab-grass appeared in it, often so thickly as to necessitate plowing under the whole lawn. Two sparrows were fed with 100 of the seeds. Instead of manipulating them as they did the seeds of millet and pigeon-grass they swallowed them whole,

without removing any of the ensheathing glumes. Gravel was furnished so that the grinding power of the birds' gizzards might be facilitated, and after several hours 6 droppings were collected and examined. No whole seeds were found. There were, however, three nearly entire glumes and a pulverized mass of matter which under the microscope was seen to consist of fragments of broken glumes. Several days later about 500 crab-grass seeds were fed to the same sparrows, no gravel being given at the time or during the interval between the two experiments. Twelve droppings were examined and the results were substantially the same as in the first experiment. Three different sparrows were then fed with about 1,000 crab-grass seeds and 20 droppings were collected. The result was the same. Not one of the 1,600 seeds was passed in a condition to germinate. Although these experiments are by no means conclusive, yet they strongly indicate that the English sparrow, however harmful it may be in other ways, can not be held responsible for the occurrence of crab-grass in lawns. It is possible that the damage is due to the wind. Seeds of crab-grass are light and buoyant, and those attached to fallen spikes would be particularly likely to be carried along by the wind on gusty days.

FOOD OF SPARROWS BY SPECIES.

SNOWFLAKE.

(*Passerina nivalis.*)

The snowflake is a bird of the arctic tundra, above the limit of tree growth. In North America it breeds about Hudson Bay, in the northernmost parts of Labrador and Alaska, and to the northward. In its northern home it is a white, black-blotched sparrow, of whose habits very little is known, except that it makes a feather-lined nest on the ground, in which it rears four to five young on a diet which probably consists principally of insects. After the breeding season, however, a buffy brown becomes mixed with the black and white, and the birds assume a more sparrow-like aspect. They migrate southward with the first severe cold weather, some of them coming as far south as the northern half of the United States, where their appearance is regarded as a sure sign that winter has begun in earnest. Often a flock of a thousand will come with a blizzard, the thermometer registering 30° to 40° below zero; and in their circling, swirling flight, as they are borne along by the blast, they might well be mistaken at a distance for veritable snowflakes. They settle in the open fields and along railroad tracks, where they secure some food from hayseed, grain that has sifted out of the grain cars, and seeds of weeds that grow along the tracks. Here they remain until April, when, in obedience to the migrating instinct, they journey north to nest on the treeless plains of the arctic regions.

The snowflake differs from many other winter sparrows, such as the tree sparrow, junco, and white-throated sparrow, in that its flocks act more nearly as units, the alarm of a single member causing the whole flock to whirl up into the air and be off. A further difference may be noted in its strictly terrestrial habits. When not flying, it is almost invariably found on the ground; and when it does happen to alight in a tree, awkward wobblings betray its discomfort. Where the feeding conditions are favorable, immense flocks of snowflakes may be seen apparently rolling like a cloud across the land, this curious effect being due to the rear rank continually rising and flying forward to a point just in advance of the rest of the flock. At times they feed in company with horned larks. This is particularly noticeable when snow has covered the tops of weeds, and the birds are obliged to repair to the crests of wind-swept knolls where the ground is comparatively bare of snow and the weeds are, consequently, exposed.

Little information can be given concerning the summer food of the bird. It is said to feed on the seeds of shore or marsh plants, and on aquatic invertebrates, including small crustaceans and mollusks. Baird, Brewer, and Ridgway state that the adult birds feed extensively during May on the buds of *Saxifraga oppositifolia*, that they hunt on the houses of Greenlanders for insect larvæ, and that a captive bird showed a liking for cracked corn and wheat.[1] In an article on the birds of the Pribilof Islands, by Mr. William Palmer,[2] there is a brief note on the habits of the Pribilof snowflake (*Passerina nivalis townsendi*), which are probably similar to those of the common snowflake (*Passerina nivalis*). Mr. Palmer submitted to me for examination the stomach contents of two old birds and five young ones secured on St. Paul Island. Every one had eaten either larval or adult flies, belonging principally to the families Chironomidæ and Tipulidæ. Some of the birds had been feeding on maggots, which they had doubtless obtained from the decaying carcasses of fur seals, at that time numerous on the island. One of the adult birds had eaten a small green leaf-beetle of the family Chrysomelidæ, and one of the young birds had eaten a spider. The only vegetable matter found was in the stomachs of two of the young birds, in one case consisting of a few fragments of grass, and in the other of 40 unidentified boat-shaped yellow seeds. Two of the young birds had swallowed little fragments of the volcanic lava of which St. Paul Island is composed. Mr. Palmer saw a parent snowflake make repeated trips to the shore of an inland lagoon for the purpose of securing for her young a supply of dead sand fleas (amphipods of the subfamily Gamarini).

Forty-six stomachs of snowflakes, collected from January to April, inclusive, mainly in Ontario, Wisconsin, Michigan, and New York, have been examined. From these examinations it appears that at this time of the year the birds are great consumers of weed seed, but that they also eat considerable grain. Professor Aughey states that in Nebraska they are accustomed to feed on the eggs of the Rocky Mountain locust during the winter;[3] but the stomachs examined in the laboratory of the Biological Survey contained nothing but vegetable matter. One-third of this was grain, while almost the whole of the remainder consisted of weed seed. Grain constituted 96 percent of the contents of the 13 stomachs collected in April, but this large percentage arises from the fact that all the April collections were made on the same day when the birds happened to be feeding on oats. Had these same birds been collected a few days earlier or later, they might have been feeding almost entirely on weed seed, which would,

[1] Hist. North American Birds, Vol. I, p. 513, 1874.

[2] Fur Seals and Fur-Seal Islands, Part 3, p. 424, 1899.

[3] First Ann. Report U. S. Entomological Commission, App. II, p. 29, 1878.

of course, have changed the character of the stomach contents, and so reduced the percentage of grain food not only for April, but for the season as well. A larger collection of stomachs would also, no doubt, have shown a smaller percentage of grain. The grain taken is for the most part gleanings after harvest, in the stubble-field, about buildings, or along roads or car tracks, and so of little or no economic importance, the kinds most frequently secured being wheat, corn, oats, and millet. Some of this may come from newly sown fields; but the amount thus taken is probably so small that such damage as results is little compared with the service rendered by the destruction of weed seed.

From the examination of the stomachs collected, it would appear that the snowflake derives fully half its subsistence from two weeds—amaranth and ragweed, and that it does not to any great extent feed on the seeds of crab-grass, pigeon-grass, or other grasses, though it should be stated that McIlwraith reports it as eating the seeds of broom sedge (*Andropogon scoparius*).[1] Only 1 percent of the food contained in the 46 stomachs examined was grass seed. But in addition to the fact that the number of stomachs examined was too small to permit final conclusions to be drawn, for other reasons this should not be taken as showing a distaste for grass seed. The taste for similar food, as shown by the partiality of the birds for grain, and the quantity of grass seed eaten by the closely allied, more southerly ranging longspurs, indicate that the abstinence of the snowflake from this food is due to necessity and not choice. We must remember that the grass seed, which falls to the ground when ripe instead of clinging to the stalk, as do many of the seeds of amaranth, lamb's-quarters, and ragweed, is probably buried under the snow during most of the time the snowflakes are here. The amaranth is tall and its seeds are particularly clinging, and after very heavy snowfalls it is probably the most available food supply the snowflakes have. Its seeds form half the food found in the stomachs collected in February and March, some of which contained from 500 to 1,500 each. Such a wholesale destruction of the seeds of this rank weed as is thus indicated is not accomplished by any other bird whose food habits have thus far been investigated. With most species of seed-eating birds amaranth is by no means an important article of diet.

On account of its good work as a weed destroyer and the apparent absence of any noticeably detrimental food habits, the snowflake seems to deserve high commendation, and should receive careful protection. Feeding in latitudes that have been deserted by most other weed-destroying birds, these birds render a distinct and most effective service to the Northern farmer. And to this should be added that it is their habit, and that of their congeners, the longspurs, to feed far

[1] Birds of Ontario, p. 310, 1894.

out in the open plains without regard to the presence of trees or shrubs. In this way they accomplish work that would otherwise be left undone; for most of the other members of the sparrow family that subsist entirely, or nearly so, on weed seed in the winter will not be found far from convenient shelter to which they can repair in case of danger.

LAPLAND LONGSPUR.

(*Calcarius lapponicus.*)

The Lapland longspur is another sparrow of the Arctic zone. It is called longspur on account of the great development of its hind claw, a feature characteristic of the snowflake, also, but to a slightly lesser degree. It ranges a little farther to the south in winter than the snowflake, and resembles the latter somewhat in its winter plumage of mixed brown, though the white-marked wings and tail of the snowflake serve to distinguish it from the longspur.

Mr. William Palmer states that the longspur of St. Paul Island (*Calcarius lapponicus alascensis*) builds a grassy nest either on a slope or on the open tundra, in which 5 eggs are usually laid. He collected 6 nestlings in whose stomachs was found, as in the stomachs of the young snowflakes of St. Paul Island, the red and black volcanic lava of which the island is composed. One of the longspur stomachs contained in addition a few fragments of the cuticle of small insects, but the others showed no traces of anything but the lava.[1]

Of the winter habits considerably more is known. The birds come with the snowflakes in the autumn and go away with them in the spring. Like the snowflakes, they are protectively colored, strictly terrestrial, and highly gregarious. Baird, Brewer, and Ridgway state, quoting Richardson, that longspurs eat grass seed, juniper berries, and the samaras of pines.[2] In his interesting account of the Lapland longspur in 'Birds of Manitoba,' Mr. Ernest Seton Thompson speaks of seeing on the plains flocks of tens of thousands, and refers to their voices as a tornado of whistling. He states that in May these enormous flocks feed in newly sown grainfields, and that the stomachs of the birds he shot contained oats, wheat, buckwheat, and grass seed.[3] Professor Aughey found that longspurs, like the snowflakes, had fed on eggs of Rocky Mountain locusts.[4]

The following details are based on the examination of 113 stomachs, collected from December to May, inclusive, in the States of Wisconsin, Illinois, Minnesota, Iowa, Kansas, and Texas. The examinations, as

[1] Fur Seals and Fur-Seal Islands, part 3, p. 423, 1899.

[2] Hist. North American Birds, Vol. I, pp. 516 and 517, 1874.

[3] Proc. U. S. Nat. Mus., Vol. XIII, p. 590, 1890.

[4] First Ann. Report U. S. Entomological Commission, App. II, p. 29, 1878.

might be expected from the time and places of collection, show a very small quantity of animal food, only 6 percent, composed entirely of insects, the remaining 94 percent of the food being grain and weed seed. The largest percentage of insect food for any one month is 24 percent taken in December, an unusual month in which to find the maximum insect consumption. This apparent anomaly is readily explained, however, by the fact that all the December stomachs were collected in Texas, where insects are active throughout the winter and where the birds thus have opportunities for insect diet that do not prevail in more northerly sections. The insects making up the December food consist of weevils, ground-beetles, leaf-beetles (of the genus *Systena*), and grasshoppers (of the genus *Tettix*). No insects were eaten during the other months, except in May, when one longspur had caught a spider and another had eaten several cocoons of a certain species of tineid moth, which is also an occasional article of diet with the closely allied snowflake.

As indicated by stomach examination, Lapland longspurs derive nearly three-fourths of their subsistence in winter from grain and grass seed. The remainder is divided among such plants as ragweed, sorrel, amaranth, lamb's-quarters, purslane, sedge, and different polygonums. The grain taken consists chiefly of oats, wheat, barley, and millet, and constitutes 27 percent of the total food, millet alone making up 19 percent; but most of the birds whose stomachs contained grain were collected in stubble-fields, where they were feeding on waste grain, and so doing no damage to crops. Probably newly sown fields suffer most from their visits. They eat millet with avidity whenever and wherever it can be obtained, and undoubtedly would seriously damage this crop if it were not that it is sown after they have left for the north in the spring and harvested before they return in the autumn. They may possibly make themselves obnoxious in certain sections, as do the tree sparrows and English sparrows, by plundering millet stacks left exposed during winter; but thus far there has been no evidence of this, and it seems probable that little or no harm is done in this way. The quantity of waste millet they eat, however, lessens their effectiveness as weed destroyers. Of the food of 40 birds that were collected from a Kansas farm in January, in or near millet stubble, 63 percent consisted of millet.

When, as frequently happens, neither millet nor other grain is available, the longspur resorts to the seeds of other similar plants, destroying large quantities of the seeds of such noxious weeds as pigeon-grass, crab-grass, and other panicums. And in high latitudes, where all such plants are snow covered, they feed on amaranth, lamb's-quarters, polygonums, and ragweed. Like the snowflakes, they are to be credited with feeding in higher latitudes than are occupied by other sparrows during the winter, and on more open plains than the others frequent.

VESPER SPARROW.

(*Poœcetes gramineus and Poœcetes g. confinis.*)

The vesper sparrow is a bird of the upper Austral and Transition zones. Its breeding range covers such portions of the United States and Canada as are included in these zones, though it rarely or casually occurs in the Great Basin and California. In winter it is found from the southern part of this range as far south as Vera Cruz, Mexico. It is a bird of the dry, open upland, where its attractive song may be heard throughout the summer, particularly in the evening. It is found most frequently along roadsides or in grassy fields. When disturbed while feeding it flits up from the ground, spreading its white-splashed tail, and alights but a short distance away to resume its work. It is not as gregarious as the snowflake and Lapland longspur; for although several families may usually be seen in one company during the summer, and loose flocks of 20 to 50 may be noted during the southern migration, yet no such immense concourses are to be encountered as are frequently seen in the cases of those birds.

One hundred and thirty stomachs of vesper sparrows, collected from a dozen States, but mostly from Massachusetts, New York, Iowa, and Kansas, have been examined. The food for the year, exclusive of March, as indicated by these stomach examinations, consists of 69 percent of vegetable matter and 31 percent of animal matter.

The diet of a bird varies with the season. Thus, during the winter, practically the entire food of this sparrow is vegetable matter, while in summer its food is mainly animal matter. The animal food, at zero in winter when the snow covers the ground, rises with the temperature of the advancing season, and attains its maximum of 90 percent with the full heat of summer. It then gradually falls as summer declines and autumn progresses, until the return of winter again marks its minimum. The animal matter consumed comprises one-third of the total food of the year, and is made up of insects. The vegetable food consists of seeds. The insect portion of the diet is divided as follows: Beetles, 12 percent; grasshoppers and other Orthoptera, 11 percent; smooth, hairless caterpillars, 5 percent, and bugs (Heteroptera and Jassidæ), ants, and other Hymenoptera, taken together, 2 percent. Beetles and grasshoppers form the bulk of the animal food, as they do with many other species of birds. As soon as the beetles begin to crawl and take wing the bird is on the alert to capture them, and by May they have increased to one-third of the total food; but as grasshoppers become more and more abundant with the further progress of the season, these increase proportionately in the food until they become its chief constituent. The bird, however, is evidently very partial to beetles, and does not abandon them when the grasshopper diet is at its maximum, and even in winter an occasional hibernating beetle is plucked from its winter quarters and eaten.

Dung-beetles, weevils, click-beetles, ground-beetles, and leaf-beetles seem to be preferred to other kinds. The little dung-beetles of the genera *Aphodius* and *Ataenius*, which are extremely abundant in the pastures where the vesper sparrow nests, form 4 percent of the year's food. As they are practically neutral, however, in their effect upon agriculture, their destruction is of little interest. The destruction of weevils is more serviceable, for these include many of our worst pests. Weevils of the genus *Sitones* and several other members of the family Curculionidæ are small, hard insects, apparently as inedible as gravel, but they seem to be relished, as they form 4 percent of the year's food, and in June amount to 20 percent of the food for that month. Click-beetles, which are also pests, are taken to about half this extent. Useful predaceous beetles amount to 2 percent of the year's food. Remains of ground-beetles and their larvæ were found in four of the 130 stomachs examined. In one of these was also found a tiger-beetle, a most active flying insect that seldom falls prey to birds. The remaining 1 percent of the coleopterous food consists of small dark or green leaf-beetles of practically no economic importance, which seem to be eaten most freely in midsummer.

From June to September grasshoppers and other Orthoptera predominate over all other forms of insect food. Those eaten are principally short-horned grasshoppers of the genus *Melanoplus* and allied genera. In July, when they attain their maximum, they constitute 41 percent of the month's food. Professor Aughey found that every one of five vesper sparrows he collected and examined had fed on these destructive insects, and that the stomachs averaged more than 13 each.

Cutworms, army worms, and other smooth caterpillars that infest upland grass lands are less prominent in the food of the vesper sparrow than grasshoppers and beetles, perhaps because they are less readily obtainable. They are eaten freely, however, and, as far as is shown by this investigation, form a larger proportion of the food of this sparrow than of that of any other, with the exception of the grasshopper sparrow and the dickcissel. In May they constitute 21 percent of the food. The remainder of the animal food is unimportant, and includes ants and other Hymenoptera, true bugs, leaf-hoppers, flies, spiders, snails, and according to Dr. Warren, earthworms.[1] These various elements amount to about 3 percent of the total animal food.

Sparrows are primarily seed-eating birds, and it is usually the vegetable element of their diet that is most conspicuous and most important. While this is also true of the vesper sparrow, yet it is true to a smaller degree than is common among sparrows. Its work as an insect destroyer is very great, measured by the sparrow standard, and becomes

[1] Birds of Pennsylvania, revised ed., p. 234, 1890.

unusually prominent, particularly in summer. In July, when insects are abundant, the vegetable food declines to a tenth of the total food. Shortly after the beginning of August, however, it begins to rise steadily, until by winter it forms the entire fare. According to Dr. Warren, it includes, besides seeds, such fruits as mulberries, blackberries, and strawberries, and the buds of beech, maple, and apple;[1] but the examination of stomachs in the laboratory of the Biological Survey has as yet failed to disclose any other vegetable food than seeds. These seeds belong to the usual three groups, grain (11 percent), grass seed (16 percent), and weed seed (42 percent). Grain was found in 15 stomachs, of which 14 contained oats, the other wheat. Much of the grain was undoubtedly gleaned from stubble-fields; and it is probable that part of the oats had been taken from horse droppings, as this sparrow frequents roadsides. Several of the birds whose stomachs contained oats were collected on highways.

The maximum amount of grain, 20 percent, was procured from oat stubble in August. Four stomachs collected near oat stubble at Dry Creek, Montana, contained little else than oats. Oats were also conspicuous in stomachs of birds collected from stubble-fields at Escondido, Cal., during November and December. Some little damage may be caused to grain at harvest or sowing time, but thus far no complaints against this sparrow have been received by the Department of Agriculture.

The vesper sparrow is less partial to grass seed than many other species of sparrows, but agrees closely with them in the kinds selected. Pigeon-grass and crab-grass are eaten, and, to a slight extent, timothy and paspalum. The quantity of grass seed consumed being comparatively small, that of weed seed, which includes the seeds of ragweed, amaranth, lamb's-quarters, wild sunflowers, polygonums, and purslane, is correspondingly large. Ragweed and various polygonums alone furnish 16 percent of the food, which equals the percentage of all the various kinds of grass seeds combined. Amaranth and lamb's-quarters are, apparently, not relished as greatly as purslane and wild sunflower, to which the bird seems to be extremely partial. Although the vesper sparrow is not found as far from cover as the snowflake and the longspur, yet it feeds farther out in the field than most sparrows, and thus accomplishes more valuable service as a weed destroyer than many that feed to an equal extent on weed seed. This same characteristic increases the efficiency of this highly insectivorous sparrow as a consumer of grasshoppers, caterpillars, and weevils. Its value to the farmer is beyond question and should secure for it the fullest protection.

[1] Birds of Pennsylvania, revised ed., p. 234, 1890.

IPSWICH SPARROW.

(*Ammodramus princeps.*)

The Ipswich sparrow, a comparatively new bird to science, was discovered by Mr. C. J. Maynard among the sand hills of Ipswich, Mass., in 1868. Its breeding place was not known until 1884, and its breeding range was fully established only a few years ago. In 1894 Dr. Jonathan Dwight, jr., discovered that it breeds only on Sable Island, a small sandy islet about 100 miles off the coast of Nova Scotia. In winter it migrates to the mainland and may be found along the coast south to New Jersey and as an accidental visitant as far as Georgia. The bird is likely to be confused with its congener, the savanna sparrow, and with the vesper sparrow, but it is lighter and larger than the former, and in flight may be readily distinguished from the latter by the absence of white in its outspread tail. It is a very rare bird, and this fact, added to its exceedingly limited range, prevents it from having any appreciable economic importance.

The notes on its food habits, contained in Dr. Dwight's comprehensive monograph,[1] are based on the examination of 56 stomachs, which he collected both in winter and summer and submitted for examination to Prof. F. E. L. Beal. It was found that in summer four-fifths of the food consists of animal matter, while in winter more than four-fifths is vegetable matter. A great deal of mineral matter is also taken into the stomach. It is a curious fact that one-third of the contents of winter stomachs was found to be sand. The vegetable food comprises seeds and berries. Grass seed, particularly in winter, forms the staple diet, the little round red seeds of *Eragrostis* being very often selected. Lamb's-quarters, different polygonums, and dock are also taken, and one stomach collected on the sand hills of Rockaway Beach, Long Island, on December 17, contained several kernels of rye. The fruit element consists of bayberries, blueberries, and bunchberries.

The animal food is made up of beetles, wasp-like insects, bugs, caterpillars, flies, spiders, and snails. In June the most common article of diet is the little dung-beetle (*Aphodius fimetarius*). Tiger-beetles are also eaten, a rather unusual element of sparrow fare, but due, probably, to the abundance of these active insects upon the sand dunes which the bird frequents.

SAVANNA SPARROW.

(*Ammodramus sandwichensis savanna* and *Ammodramus s. alaudinus.*)

The savanna sparrow, as just stated, resembles the Ipswich sparrow. There is also some danger of confusing it with the song sparrow, to which it is similar in general appearance; but it lacks the black breast patch which is usually so conspicuous in the latter, and has

[1] Memoirs Nuttall Ornithological Club, No. II, pp. 41, 42, 1895.

a yellow mark behind the nostril which the song sparrow lacks. Taking the two subspecies together, the savanna sparrow has an extensive breeding range. That of the eastern bird (*Ammodramus sandwichensis savanna*) extends from Labrador and the Hudson Bay region southward through Canada into the northern tier of States, while that of the western bird reaches the Arctic coast on the north and the Mexican border on the south. The summer habitat thus comprises parts of the Boreal, Transition, and Upper and Lower Austral zones. In winter the bird is found in the Southern States and Mexico and sometimes in Cuba.

Examination has been made of 119 stomachs. These represent all the months of the year except December and February, and were collected in 12 States ranging from Massachusetts to California and in the District of Columbia, Nova Scotia, and Newfoundland. Their food contents consisted of 46 percent of animal matter, insects and their allies, and 54 percent of vegetable matter, practically all seeds. The savanna, Ipswich, and grasshopper sparrows, and, to a slighter degree, all other members of the genus *Ammodramus*, are much more highly insectivorous than other sparrows. They take equal rank in this regard with such notable insect destroyers as the catbird, robin, and bluebird. With the savanna sparrow the distribution of animal matter is as follows: Coleoptera, 15 percent; Lepidoptera, 9 percent; Orthoptera, 8 percent; Hymenoptera, 5 percent; Hemiptera, 2 percent; Diptera and miscellaneous insects, 4 percent, and spiders, with a few snails, 3 percent.

This sparrow appears to be the greatest eater of beetles of all the sparrow family. Beetles constitute the most important element of its animal food, and are eaten during every month in which stomachs were obtained, though of course in very small quantities during the winter months. In May and June they are so eagerly sought that they form one-third of the entire food of those months. Ground-beetles, leaf-beetles, and weevils (Rhyncophora) are most frequently selected, but click-beetles, dung-beetles (*Aphodius*), rove-beetles (*Staphylinus*), pill-beetles (Byrrhidæ), and certain allies of the firefly (Lampyridæ) are also eaten. Of the three groups first mentioned weevils are apparently preferred. These destructive insects are eaten to the extent of several times as much as any other kind. In August 11 percent of the food consists solely of weevils, mainly of the genus *Sitones* and related forms. The leaf-beetles taken include the genera *Chætocnema* and *Chlamys*. Some harm is done by the destruction of several of the more useful species of ground-beetles, but as these amount to but 2 percent of the total food they constitute a small offset to the favorable character of the rest of the beetle food. The lepidopterous food does not differ noticeably from that of sparrows generally; that is to say, it consists of Noctuidæ, taken usually as larvæ. Army worms were found in several stomachs collected in the

State of New York during an invasion of these pests in 1896. In its destruction of Orthoptera the savanna sparrow resembles the vesper sparrow, especially in the kinds chosen, though it is somewhat less efficient. Still, it does excellent work, for it takes grasshoppers in quantity from June to August, and in July eats them to such an extent that they constitute 34 percent of its food during that month. Ants amount to about 4 percent of the diet, and include both typical ants (Formicidæ) and stinging ants (Myrmicidæ). This shows a greater predilection for these insects than is displayed by any other sparrow, with the exception of the white-throat. The Hemiptera taken comprise both true bugs and leaf-hoppers and the Diptera consist of crane-flies and small species of horseflies.

The character of the vegetable food shows the savanna sparrow to be a great consumer of grass seeds. It is not harmful to grainfields, however, as the grain taken amounts to only about 1 percent of the food, and this consists almost entirely of waste wheat and oats. During August, a month in which many birds exhibit a great liking for a cereal diet, a number of savanna sparrows were collected from oat and barley fields, but their stomachs contained nothing but insects. Grass seed, largely pigeon-grass (*Chætocloa*) and panic-grass (*Panicum*), amounts to 31 percent of the food. Other seeds, mainly such weed seeds as are taken by the vesper sparrow, make up practically all of the remaining 22 percent of the vegetable matter, the only exception being a few blueberries found in one of the stomachs.

It appears from this examination that the savanna sparrow is an exceedingly valuable bird. During the winter, when it is most granivorous, more than half of its food consists of weed seeds; and from May to August, when it is most insectivorous, beneficial insects form only 3 percent of the food, while insects of the injurious class amount to 45 percent.

GRASSHOPPER SPARROW.

(*Ammodramus savannarum passerinus* and *Ammodramus s. perpallidus.*)

The grasshopper sparrow, also known as the yellow-winged sparrow because of the bright yellow on the outer edge of the wing, is a terrestrial species. It is not in the least degree gregarious, being found only in pairs, or at most families, in the dry, open, grassy or weedy upland which it frequents. It breeds in suitable localities throughout the entire eastern part of the United States and westward to and including the Great Basin, though it is not common west of the Rocky Mountains. But its range does not include the higher altitudes, nor always the higher latitudes, those that belong to the upper part of the Transition zone marking the lowest limit of its absence. Hence it is not found in the mountains or certain parts of the northern border, although in some places a milder climate carries its summer range into Canada.

An examination has been made of 170 stomachs of this sparrow, collected from both the East and the West and from February to October, omitting March. The food for the months represented, as indicated by the stomach examinations, consists of 63 percent animal matter and 37 percent vegetable matter. The percentage of animal matter is thus even greater than in the case of the savanna sparrow. Fifty-seven percent of the food is composed of insects, and 6 percent—the remaining animal matter—consists principally of spiders, with an occasional myriapod, snail, or earthworm. The beneficial insects consumed, comprising both larval and adult ground-beetles and parasitic Hymenoptera, amount to only 1 percent of the total food; while the destruction of injurious insects is forty-five times as great, and is distributed as follows: 8 percent harmful beetles, 14 percent caterpillars, and 23 percent grasshoppers. The beetles belong to three families: Click-beetles, mostly small species; weevils (*Sitones* and related genera); and the smaller leaf-beetles, noticeably *Systena blanda* and *Systena elongata*. Caterpillars are eaten more freely in May than at any other time, and constitute 33 percent of the food of that month. More than half the caterpillars destroyed are cutworms, which is a very large proportion, and shows an unusual liking for these destructive insects. In one stomach from Bourbon County, Ky., were 6 cutworms (*Nephelodes violans*), each an inch long. The army worm seems to be also a favorite article of diet.

The grasshopper sparrow received its name because of the character of its song, which closely resembles the stridulation of the long-horned grasshopper; but investigation of its food habits has shown that, by a curious coincidence, the name is fully as appropriate in consideration of its diet. Grasshoppers (Acrididæ and Locustidæ) form almost one-fourth (23 percent) of the food of the eight months in which the 170 stomachs examined were collected, and 60 percent of the food of June, in which the greatest quantity of these destructive insects is eaten. The genera *Xiphidium*, *Scudderia*, *Hippiscus*, and *Melanoplus* are best represented.

Among the sparrows of the farm seven are preeminently grasshopper destroyers—the dickcissel, and the grasshopper, lark, vesper, chipping, song, and field sparrows—and from May to August, inclusive, the insect-eating period, consume large quantities of these pests. The examinations of stomachs collected during this period show that grasshoppers form 41 percent of the food of the dickcissel, 37 percent of that of the grasshopper sparrow, 31 percent of that of the lark sparrow, 23 percent of that of the vesper sparrow, 21 percent of that of the chipping sparrow, 17 percent of that of the song sparrow, and 13 percent of that of the field sparrow. Among the stomachs of the dickcissel and grasshopper sparrows examined, however, were those of several nestlings, 14 and 13 of the two species, respectively; and as young sparrows are reared largely upon grasshoppers some allowance has to be made in

these exceptional cases. But enough is certain to show that these two birds and the lark sparrow are most valuable destroyers of grasshoppers, while the work of the other four sparrows mentioned, though not so extensive, is yet of much importance. These figures give new meaning to the name by which the grasshopper sparrow is known.

Eleven percent of the total food comprises such insects as ants and little dung-beetles (*Atœnius* and *Aphodius*), and about 1 percent consists of bugs, the most common being leaf-hoppers (Jassidæ), leaf bugs (Capsidæ), assassin bugs (Reduviidæ), and the smaller soldier bugs, such as *Hymenarcys* and *Trichopepla*. The spiders, myriapods, earthworms, and snails, which constitute the remaining animal matter, should be classed as probably neutral.

The vegetable food of the grasshopper sparrow is of little importance when compared with that of other species. No fruit was found excepting a few blueberries in one of the stomachs, and grain, chiefly waste, forms only 2 percent of the food Of the seeds, wood sorrel (*Oxalis*) composes 2 percent of the food; ragweed, 5 percent; such grasses as pigeon-grass, panic-grass, and a few others less freely eaten, 17 percent; and various other plants—polygonums, purslane, rib-grass, and the sedges—11 percent. The entire weed-seed element, including the seeds of such grasses as are troublesome on the farm (7 percent of the total food), amounts to about one-fourth of the food.

The grasshopper sparrow in particular and the other species of the genus *Ammodramus* in general feed much less on vegetable matter than most other sparrows. Insects form their staple diet, and of these, beetles, grasshoppers, and caterpillars are the most important. As a destroyer of insect pests the grasshopper sparrow is most efficient. It is not only superior to other members of the same genus, but is even more efficient than such valuable species as the lark sparrow, vesper sparrow, and dickcissel; and, both its vegetable and animal food considered, it seems to be individually the most useful species of bird whose food habits have thus far been investigated. The injurious part of the food forms only 3 percent of the whole, while the neutral amounts to 24 percent and the beneficial to 73 percent.

HENSLOW'S SPARROW.

(*Ammodramus henslowi.*)

Henslow's sparrow is a rare and locally distributed bird of the eastern half of the United States. In appearance and habits it is similar to the grasshopper sparrow.

Four stomachs collected during the summer months contained beetles, cutworms, grasshoppers, bugs, and blackberries. The beetles consisted of ground-beetles (*Anisodactylus*), leaf-beetles, click-beetles, and weevils (Rhynchophora); the bugs, of soldier bugs and assassin bugs (Reduviidæ). Three stomachs collected on January 29 at Dallas,

Tex., contained a spider, fragments of grass, and seeds of plants of the composite family.

Because of its small numbers and irregular, local distribution, this sparrow is of little economic importance.

SHARP-TAILED SPARROW.

(*Ammodramus caudacutus*, *A. nelsoni*, and *A. n. subvirgatus*.)

The sharp-tailed sparrow is so called from the fact that its tail feathers end in drawn-out points. With the exception of one species, Nelson's sharp-tailed sparrow, this is a bird of the Atlantic coast, breeding from Nova Scotia to Maryland and possibly to Virginia, and ranging southward in winter as far as the Gulf of Mexico. Nelson's sparrow (*Ammodramus nelsoni*) breeds in the fresh-water marshes of Illinois, Dakota, and Manitoba, but migrates in winter to the Atlantic and Gulf coasts.

Fifty-one stomachs of this sparrow, collected from May to October, that have been examined, contained 81 percent of animal matter and 19 percent of vegetable matter, chiefly grass seed. The animal food is distributed as follows: Hymenoptera, 3 percent; Coleoptera, 6 percent; Orthoptera, 7 percent; Lepidoptera, 14 percent; Hemiptera, 12 percent; Diptera, 5 percent; miscellaneous insects, 8 percent; and Amphipoda (sand fleas), Arachnida (spiders), and Mollusca (snails), 26 percent. The Hymenoptera were ants and Ichneumonidæ. The beetles were mainly *Sitones* and other weevils, some small ground-beetles, and occasionally a leaf-beetle, a rove-beetle, a tiger-beetle, or a dung-beetle. The Orthoptera were for the most part short-horned grasshoppers (Acrididæ), but some long-horned grasshoppers and crickets were taken. Sixteen of the birds had eaten Lepidoptera, a large number in view of the fact that all the birds examined were adults. One-third of the Lepidoptera were eaten as imagos, and these were practically all noctuid moths. These insects were so comminuted in the stomach contents that they could be recognized as moths only by pieces of their slender coiled probosces, or through a microscopic examination of the pulverized remains, which disclosed the characteristic toothed scales that make the down on their wings.

The food habits of the sharp-tailed sparrow have many striking peculiarities. The bird shows a greater liking than most species for bugs; and half of those eaten belong to the homopterous division and are for the most part leaf-hoppers (Jassidæ). These insects are, it is true, wonderfully abundant in the moist, grassy places where this sparrow lives, but they are not often eaten by other birds that inhabit the same kinds of places. Of the true bugs—that is, those belonging to the heteropterous division—both the smaller plant-feeding and the predaceous species are eaten. Perhaps the most

curious feature of the bird's food habits is the liking shown for Diptera. These insects, mainly midges (Chironomidæ) and their larvæ, certain allied insects, and the smaller adult horseflies (Tabanidæ) constitute 5 percent of the food, probably a larger proportion of Diptera than characterizes the food of any other birds except flycatchers and those shore-inhabiting species in the far north which feed so extensively on Chironomidæ.

There is a difference in the food of the sharp-tailed sparrows collected by the salt water and those taken near fresh water, owing, no doubt, to difference of environment. The (28) salt-water birds had eaten no vegetable food but grass seed, while 7 of the (23) birds taken near fresh water (at Hillsborough, Nova Scotia) had also eaten other seeds, such as those of polygonum, lamb's-quarters, clover, and dandelion. The salt-water birds feed on the seeds of salt grasses and occasionally eat wild rice (*Zizania aquatica*); the fresh-water birds eat other grasses, particularly panicums.

The salt-water birds eat many sand fleas, small amphipod crustaceans belonging to the family Gammaridæ. These sand fleas are very abundant along the beach, and the birds pick them up either on the clean sand or amid seaweed or other shore débris. They constitute 16 percent of the food of the salt-water birds, but were not found in the stomachs of the fresh-water birds. Not one of the fresh-water birds had eaten a snail, while six of the other birds had found snails very palatable; in fact, one had eaten four at a meal. The birds collected in fresh-water marshes had fed on army worms.

The economic position of this sparrow is so similar to that of the next species, the seaside sparrow, that for the sake of convenience the two birds will be grouped together in considering their relation to crops.

SEASIDE SPARROW.

(*Ammodramus maritimus.*)

The seaside sparrow is a very dark-colored bird for a sparrow, and has a yellow line behind each nostril. It breeds along the Atlantic coast from Massachusetts to Georgia, and is characteristic of the seashore. Unlike the sharp-tailed sparrow, it is never found away from salt water. Often, particularly in autumn, seaside and sharp-tailed sparrows may be found congregated in loose flocks.

The food habits of the two sparrows are very similar, both in elements and proportions of the food. There are, however, some minor differences of details. Thus, the seaside sparrow does not take nearly so many sand fleas (Amphipoda) as its congener, and according to Baird, Brewer, and Ridgway,[1] it feeds on small crabs, which as far as known form no part of the food of the sharp-tailed sparrow.

[1] Hist. North American Birds, Vol. I, p. 561. 1874.

The sharp-tailed and seaside sparrows have a very limited range, a mere strip on the Atlantic coast, and probably do not come in contact to any extent with cultivated crops. In so far as they destroy insect enemies of salt-marsh hay they are helpful, and in so far as they destroy enemies of insects which prey upon this crop, they are harmful; but otherwise they exercise little influence on agriculture. The examination of 81 stomachs of both species indicates that 2 percent of the food consists of insects which probably exert a beneficial influence on the salt-hay crop, 30 percent consists of insects which are perhaps injurious to it, and 10 percent consists of spiders, concerning whose relation to it there is much doubt. The remaining 58 percent of the food is made up of approximately equal parts of insects and seeds of plants having little, if any, relation to the hay crop. The birds do not prey on the salt-marsh caterpillars, so destructive to the hay, and they destroy a considerable amount of the seed of the marsh grasses, which is probably an injurious effect. Thus, investigation shows that the two species are apparently of little economic importance.

LARK SPARROW.

(*Chondestes grammacus* and *Chondestes g. strigatus.*)

The lark sparrow (fig. 31), also called snake bird in certain localities on account of its striped head, is extremely abundant on the plain

FIG. 15.—Lark sparrow.

and prairie regions of the United States. It is found in open country from the Pacific coast almost to the Alleghenies and from British Columbia and Manitoba as far south as Mexico and Guatemala. The white feathers in its tail suggest the vesper sparrow, a bird with which it agrees quite closely in habits and habitat. It is strikingly marked

and a very fine songster, two qualities that have caused it to become a favorite cage bird.

Its food habits have been investigated by the examination of the contents of 167 stomachs, collected during every month in the year except March. Most of these stomachs were collected in Kansas, Texas, and California, but a number were taken in the Dakotas, Michigan, Iowa, and the Province of Ontario. The food consists of animal matter (all insects) 27 percent, and vegetable matter (all seeds) 73 percent.

The lark sparrow is, with the exception of the dickcissel and grasshopper sparrow, the most valuable grasshopper destroyer of all the native sparrows. More than half of its animal food (14 percent of the total) consists of these insects, and in June they constitute 43 percent of the diet. On the prairies and plains this bird does much good in helping to check invasions of the Rocky Mountain locust. The preponderance of grasshopper food in the diet dwarfs the other elements of the insect fare, which is rather less in proportion than is usual with sparrows. A fair quantity of weevils was found in the stomachs, but other beetles as well as caterpillars appear far below the general average, although in its elements the animal food conforms well with that of other species of sparrows.

The vegetable food is of especial interest. One-half of it consists of the seeds of grain and grass, a fact which fully sustains the bird's specific name of *grammacus*. Pigeon-grass is largely fed on, but a marked partiality is likewise shown for grasses of the genus *Panicum*. The seeds of Johnson grass are also eaten freely, especially in the case of birds collected in Texas in December. The total consumption of the seeds of various grasses during the year amounts to 21 percent of the food.

The lark sparrow is more of a grain eater than the majority of other native sparrows; corn, wheat, and oats constitute 13 percent of its diet. The greatest part, however, is secured in winter; the maximum amount, 42 percent, is eaten in January, and grain constitutes 28 percent of the February food; hence, much of it must be picked up as waste. The birds collected during April, May, and September, when grain is usually sown, had eaten nothing but weed seeds and insects, which seems to show that the lark sparrow takes no part in the disturbance of newly sown grain, so annoying in the case of some species of grain-eating birds; and though cereals form 19 percent of the food of July and 12 percent of that of August, no complaints of damage to harvests have been received by the Department, and it is likely that much, if not all, that is taken at this time is picked up from the ground, and that its grain eating is therefore of little consequence.

The most peculiar feeding habit of the lark sparrow is its partiality for the seeds of leguminous plants, such as those of cassia, clover, and alfalfa, which are freely eaten. They form 8 percent of the food for

the entire year, but this percentage is probably larger than it would have been had the stomachs which were examined been collected from more localities. Most of the birds that had eaten largely of these seeds were obtained during the months of November, December, and January in southern California, and to quite an extent from newly sown alfalfa fields.

About half of the remaining 30 percent of the food consists of ragweed and polygonum nearly equally divided, while the rest is made up of a variety of weed seeds, among which those of wild sunflowers and purslane appear the most prominent, while wood sorrel (*Oxalis*), lamb's-quarters, and amaranth play a minor part.

From this investigation it appears that the lark sparrow merits a high place among the useful tenants of the farm. The weed seed destroyed more than twice outweighs the grain consumed, which, as shown, is probably not taken in a harmful way; and beneficial insects do not rise to 1 percent of the food, while injurious insects amount to 25 percent.

HARRIS'S SPARROW.

(*Zonotrichia querula.*)

Harris's sparrow occurs from Saskatchewan south to Texas, and is not found regularly west of Montana or east of Illinois. It rivals the fox sparrow in size, and is of most striking appearance in its summer dress, with its glossy black crown and throat, large reddish beak, and bright coat of the usual sparrow mixture of colors. In winter the black is lost from the plumage and the bird resembles a long-tailed immature male English sparrow.

In habits Harris's sparrow is most like its two congeners, the white-throated and white-crowned sparrows. Nehrling speaks of observing it in Texas during November mixed in with flocks of thousands of juncos, white-crowned, and field sparrows. In these flocks there were seldom more than six to twelve Harris's sparrows. He caught several and kept them in confinement. They became tame and relished grasshoppers, moths, beetles, millet, kafir corn, and canary seed.

One hundred stomachs have been examined, which were collected principally in Saskatchewan, Kansas, and Texas, from October to May, inclusive. As is the case with many of the birds that breed for the most part to the north and merely winter with us, the stomach contents are chiefly vegetable in character, the animal matter amounting to but 8 percent. This 8 percent comprises about the same kinds of insects, spiders, and snails that enter into the fare of other sparrows, but the quantity of leaf-hoppers is unusually large (2 percent of the food), a taste which this sparrow shares with the sharp-tailed sparrow and Thurber's junco. Of the vegetable food, 25 percent is made up of the seeds of wild fruits and various miscellaneous plants of uncertain economic position; 10 percent of grain, which includes rather

more corn than wheat and oats and is chiefly waste kernels; 9 percent of grass seed, mainly pigeon-grass, crab-grass, June grass, paspalum, and Johnson grass; 6 percent of the seeds of amaranth, lamb's-quarters, wild sunflower, and gromwell, and 42 percent of ragweed and polygonum. These figures indicate that it is advisable to afford this species all possible encouragement and protection.

WHITE-CROWNED SPARROW.

(*Zonotrichia leucophrys, Zonotrichia l. gambeli, and Zonotrichia l. nuttalli.*)

There are three subspecies, or geographic races, of white-crowned sparrows. The first that was described, *Zonotrichia leucophrys*, is a bird of the Hudsonian life zone, breeding in the very high mountains of the western United States and eastward to Labrador and the Hudson Bay region. In winter it is found throughout the United States and as far south as the valley of Mexico. The second subspecies, Gambel's sparrow (*Zonotrichia leucophrys gambeli*), is not found east of the Great Plains, and breeds to the north of the United States. The third subspecies, Nuttall's sparrow (*Zonotrichia leucophrys nuttalli*), is confined to the Pacific coast region, and occurs from British Columbia to Lower California.

Two hundred and seventeen stomachs of these three subspecies, collected during every month of the year except August, have been examined. One-fourth of the food contained in these stomachs was found to consist of animal matter, and three-fourths of vegetable matter. The animal portion resembles that of other sparrows in character, but differs somewhat in the proportions of the various constituents. Caterpillars form 9 percent of the total food, or more than one-third of the animal food, which is in excess of the usual proportion of these pests found in sparrow stomachs. Ants and parasitic wasps amount to 6 percent of the total food, also an unusually large proportion. The percentage of beetles (5 percent) is, on the contrary, rather below the average; and that of grasshoppers (1 percent) is remarkably small. The remaining 4 percent of the animal food is composed of spiders, bugs, and miscellaneous insects in the usual proportions.

The vegetable part of the food consists of 51 percent of weed seed, 15 percent of grain, 4 percent of grass seed, and 5 percent of fruit. The amount of grass seed consumed is noticeably smaller, while the fruit element is noticeably larger than is common in sparrow food. This fruit-eating proclivity and apparent lack of appetite for grass seed and grasshoppers characterizes the food habits of all the sparrows of the genus *Zonotrichia*.

Owing to marked differences of food habits among these three subspecies of white-crowned sparrows, it is desirable to consider each separately, though the limited material, especially in the case of *gambeli*, renders cautious conclusions necessary.

Ninety-four stomachs of the typical white-crowned sparrow (*Zonotrichia leucophrys*) have been examined. They were collected from September to May, inclusive, in Connecticut, Michigan, Illinois, Iowa, Kansas, Texas, and the District of Columbia. Like most of our northern sparrows, this species subsists during the winter almost entirely on seeds. Its tendency to become somewhat insectivorous in warm weather is indicated by the fact that 11 percent of the food in May and September consisted of ants, caterpillars, weevils and other beetles, and spiders. If stomachs could have been collected during the summer months, the proportion of the insect part of the food would, no doubt, have been much larger.

Of the vegetable fare, grain possesses the first interest. It consists almost entirely of oats, although in a few exceptional cases corn or wheat had been picked up. Grain was found in a quarter of the stomachs examined, and amounts to 12 percent of the total food for the year. In May it attains its maximum of 27 percent, indicating the presence of the habit of feeding in newly sown fields, though no direct evidence of this fault has been had and it is possible that the grain is largely or entirely derived from scattered waste grain. The small grass-seed item includes crab-grass and other panicums, pigeon-grass, and the Johnson grass of the South, which forms a part of the diet of the lark sparrow and Harris's sparrow.

Ragweed is as important as grass seed is unimportant, constituting 20 percent of the entire food. Amaranth, lamb's-quarters, chickweed, gromwell, and wild sunflower are also included in the weed-seed element of the food.

Fruit did not occur to any appreciable extent in the stomachs examined. Audubon states that as this sparrow passes down into the United States it feeds eagerly on grapes,[1] but no especial damage of this kind has been reported to the Department, and only 5 of the 94 stomachs contained any fruit, and they only elderberries and blackberries. This of course is merely negative evidence, and further examination may confirm Audubon's observations. Warren has noted a peculiar habit of this species in eating the blossoms of bushes and trees when it was migrating north in the spring.

By way of summary it may be stated that the total damage which this beautiful sparrow accomplishes appears from the present investigation insignificant when compared with the service it renders in reducing the weed-seed harvest.

Our knowledge of the food habits of Gambel's sparrow (*Zonotrichia leucophrys gambeli*) is exceedingly meager. Only 23 stomachs were available for examination, and 11 of these were collected on Saturnia Island, British Columbia, during the month of April. The remainder were taken in Arizona, Utah, Montana, and the Dakotas, during the months of April, May, September, and October.

[1] Birds of America, Vol. III, p. 159, 1841.

The bird appears, as well as can be judged by means of this limited material, to be much more insectivorous than the typical white-crowned sparrow. In fact as much as 70 percent of the food contents of the stomachs collected on Saturnia Island consisted of insects. Spiders and sand fleas (Amphipoda) were also eaten. Cutworms and closely allied smooth caterpillars form half of the insect food, while beetles, including ground- and leaf-beetles, weevils (Rhynchophora), scarabæids, and lampyrids (*Podabrus*), and such insects as ants and useful wasps make up the remainder of the food. These highly insectivorous habits appear surprising when the date of collection of half of the stomachs is considered. It is probable, however, that on Saturnia Island insects are obtainable much earlier than at an inland station of the same latitude, because of the comparatively mild climate of the coast.

The vegetable food proved interesting for two reasons. In the first place only one bird had eaten grain, and in the second place not one had touched grass seed. The latter fact appears in harmony with the habits of all the members of the genus, but the former is unexpected and in striking contrast with the habits of Nuttall's sparrow. The miscellaneous weed-seed element of the food includes chickweed, lamb's-quarters, wild sunflower, polygonum, and dock. A few violet and mallow seeds were also found in the stomachs.

With regard to the food of Nuttall's sparrow (*Zonotrichia leucophrys nuttalli*) it is possible to speak more authoritatively since 100 stomachs of this subspecies have been examined. These were collected in California during all the months of the year except August and September.

The summer food of this bird is of especial interest, as it affords the only clew had to the food habits at this season of the other two subspecies. A dozen stomachs were collected during June and July, which contained 43 percent of animal matter and 57 percent of vegetable matter. The insect material is distributed as follows: Orthoptera, together with larval Lepidoptera, 4 percent; Coleoptera, 9 percent; Heteroptera and Jassidæ, 7 percent, and Hymenoptera, 23 percent. Click-beetles, weevils (Rhynchophora), lampyrids (fireflies and their allies), dung-beetles (*Aphodius*), and leaf-beetles make up the bulk of the beetles. The 23 percent of Hymenoptera, which for any sparrow is unusually large, is composed for the greater part of useful parasitic species, and so must be counted heavily against the bird.

During cold weather this bird becomes a seed eater. In fact, from October to February nine-tenths of its nourishment is derived from grain, weed seed, and the seeds of plants of little economic importance. As with the preceding species, no grass seed is eaten. Owing to this apparent distaste for grass seed and to the absence of ragweed from its habitat, it seems to be forced into eating the seeds of lamb's-quarters and amaranth, which are usually a second choice with sparrows. So freely does it eat the seeds of these two weeds

from October to February that 35 percent of the food is composed of nothing else. No other sparrow, except the snowflake, takes these noxious seeds to any approximate extent. The only other weed seeds devoured in quantity by Nuttall's sparrow come from such leguminous plants as cassia, and from purslane and plants of the pink family.

The one character that chiefly serves to distinguish this sparrow from its brethren is its inordinate appetite for grain. It seems to prefer oats, but will take corn, wheat, or barley whenever an opportunity offers. The cereal element in the stomachs collected from October to February, inclusive, forms 39 percent of the total contents, and in January attains a maximum of 50 percent. The grain is obtained from newly sown fields, from standing grain, and from the harvest field where it is picked up from the stubble. The greater part of the birds whose stomachs contained the largest proportion of grain were collected in newly sown fields. Dr. T. S. Palmer has repeatedly observed this sparrow in large flocks on newly sown land and apparently causing damage.

With this bad record in the grainfield and with the destruction of an unusually large proportion of valuable parasitic wasps to be charged against it, the value of this white-crowned sparrow of the Pacific coast is open to question. The only real offset to this damaging record is to be found in the destruction of weed seeds, particularly those of lamb's-quarters and amaranth. But, full weight being allowed to this credit, the bird seems to be the least beneficial of any thus far considered.

WHITE-THROATED SPARROW.

(*Zonotrichia albicollis.*)

The white-throated sparrow (see frontispiece) is as characteristic of the Canadian zone as the typical white-crowned sparrow is of the Hudsonian. It breeds in the northern tier of States west to Montana and north into Canada, migrating in autumn into the middle Eastern States, some individuals going as far south as Florida and Mexico. It closely resembles the white-crowned sparrow in appearance and habit, but its song is distinctive, consisting of a high, plaintive, drawn-out pipe, that when once heard is seldom forgotten. In New England this song has been thought to suggest the words, Peabody! Peabody! Peabody! and the sparrow has received the name of 'Peabody bird.' Equally characteristic, though less generally known, is a curious clinking call-note that is uttered at first loudly, then in a softer, more conversational tone, when the birds are repairing in flocks to their quarters for the night during their sojourn in the South.

The white-crowned sparrow, the tree sparrow, and the fox sparrow breed in the far North, where agriculture is limited; but both the

summer and winter ranges of the white-throated sparrow are, to a considerable extent, within agricultural life zones. Its economic relations are therefore more important.

Dr. B. H. Warren states that during spring in Pennsylvania he has seen white-throated sparrows feeding on buds and blossoms of beech, maple, and apple.[1] These observations have not yet been confirmed in the laboratory examination of stomachs. While in the field in May I have noted white-throated sparrows eating the fruit of elm trees, but have never found them damaging buds or blossoms.

Two hundred and seventeen stomachs, collected during every month in the year except June, have been examined. Most of these stomachs were collected in New York and Pennsylvania, but a large number came from Iowa, Minnesota, Georgia, and Texas, and some from New Brunswick. The food for the year, as a whole, as indicated by stomach contents, consists of 19 percent animal matter and 81 percent vegetable matter. Of the vegetable food, 3 percent is grain, 50 percent weed seed, and the remainder chiefly wild fruit.

The insect food resembles that of many other species in general character, but some interesting differences appear when it is viewed in detail. Hymenoptera constitute 6 percent of the year's food; Coleoptera, 5 percent; Heteroptera and Diptera, taken together, 3 percent, and Lepidoptera, 3 percent, the customary quota of spiders, millipedes, and snails supplying the remaining 2 percent of the animal food. The Hymenoptera are distributed among parasitic species (2 percent), ants (3 percent), and miscellaneous (1 percent). In its partiality for ants the white-throated sparrow resembles the savanna sparrow. Of the beetles eaten, ground-beetles, leaf-beetles, click-beetles, weevils (Rhynchophora), and members of the families Histeridæ and Scarabæidæ enter most frequently into the diet. The Scarabæidæ include principally dung-beetles (*Aphodius*), but occasionally the larger species, such as the May-beetle or rose-beetle, are eaten. The depredations of the latter on vineyard and flower garden are seldom disturbed by birds, on which account the service done by the white-throated sparrow in eating it has added value. Weevils furnish the greater part of the beetle food, and during May, when they are eaten more freely than at any other time, form 15 percent of the food.

The same absence of Orthoptera (grasshoppers, etc.) from the food is noticeable in the investigation of the white-throat that has been noted in the case of its congener—the white-crown. These insects were selected by only 2 of the 217 birds examined. Professor Aughey, however, found that 5 individuals which he examined had devoured an average of 18 Rocky Mountain locusts apiece,[2] and a captive white-throat kept in the laboratory of the Biological Survey ate grasshoppers

[1] Birds of Pennsylvania. revised ed., p. 237. 1890.

[2] First Ann. Report U. S. Entomological Commission. App. II, p. 31, 1878.

with an avidity that bordered on greed. It would be wise, therefore, not to draw any final conclusions from the absence of grasshoppers in most of the stomachs of white-throats and white-crowns examined.

The most striking point in the food habits of this sparrow is its fondness for berries. From July to November, inclusive, one-fourth of its food consists of berries. At this time it eats the fruit of the blueberry (*Vaccinium pennsylvanicum* and other species), wild cherry (*Prunus serotina*), mountain ash (*Sorbus americana*), green-brier (*Smilax glauca*), strawberry (*Fragaria* sp.), spice bush (*Benzoin benzoin*), wild sarsaparilla (*Aralia* sp.), elder (*Sambucus canadensis*), blackberry (*Rubus villosus*), dogwood (*Cornus florida*, *alternifolia* and *stolonifera*), and the high bush cranberry (*Viburnum opulus*). White-throats have been seen feeding in large numbers on the blueberries which grow profusely upon the sides of Mount Chocorua, New Hampshire. So much does it relish food of this character that during July fruit constitutes 44 percent of the total food of the month.

In addition to eating berries as long as they last, it picks up their dry seeds and cracks them for the meat long after the fruit pulp has disappeared and the seeds have been scattered on the ground. From January to May it feeds on the seeds of such fruits as the blueberry, blackberry, elderberry, and grape. Some of these are doubtless cracked by the bird's beak, and others by the muscular grinding gizzards. Broken fragments of grape and blackberry seeds are often found in the stomachs of birds collected in the spring. Nearly one-third of the food contents of the stomachs of 33 whitethroats collected in Texas during January and February consisted of bits of the seeds or drupes of various wild berries.

It is highly probable that as these sparrows are picking up seeds of berries they get some that belonged to berries eaten at some previous time by berry-eating birds, whose stomachs were not powerful enough to crush the seeds, which, consequently, were voided and scattered upon the ground. This double consumption of seeds is also common to the different white-crowned and fox sparrows, the cardinal grosbeak, and the mourning dove.

Some grass seed is consumed, principally seeds of such troublesome species as pigeon-grass, crab-grass and other panicums, and Johnson grass. This element forms about 5 percent of the total food, and is taken chiefly during September, when it amounts to 24 percent of the food of the month. A little amaranth and lamb's-quarters are eaten; and gromwell, chickweed, wood sorrel, sedge, violet, and sheep sorrel are all represented in the diet. But the principal weed seeds found in the stomachs are those of ragweed and different polygonums. As a destroyer of ragweed this sparrow seems to have no equal among finches, and the song sparrow is its only rival as a consumer of polygonums. The two weeds form 25 percent of the food for the year, of

which ragweed furnishes 9 percent and the polygonums 16 percent. During October ragweed alone constitutes 45 percent of the month's food.

The white-throated sparrow may be regarded as a valuable bird on the farm; it has a good record as a weed destroyer, its fruit eating is largely confined to wild berries, and it does little damage to grain fields.

TREE SPARROW.

(*Spizella monticola* and *Spizella m. ochracea.*)

The tree sparrow (see frontispiece) breeds in Labrador and the Hudson Bay region and westward to Alaska. In the fall the birds come down from the north in immense throngs and spread over the United States as far south as South Carolina, Kansas, and Arizona. During the winter, in company with juncos, white-throats, white-crowns, and fox sparrows, they give life to the hedge rows, tangled thickets, and weed patches. Their song is not heard until just before they leave in the spring, but throughout the winter wherever they are encountered a mingled chorus of innumerable conversational and alarm notes greets the ear. In appearance they somewhat resemble chipping sparrows, and have sometimes been called winter chippies; but they are readily distinguished from that bird by their larger size and by a dark spot on the breast, the chipping sparrow's breast being unmarked.

Five hundred and seventeen stomachs have been examined, collected at points ranging from Massachusetts to the District of Columbia, and westward as far as Iowa and Kansas, and during the period from October to May. As indicated by these examinations, the food of the tree sparrow during its stay in the United States is almost entirely made up of seeds, which amount to 98 percent of the total food contents of the stomachs examined. The bird shows an essential difference from its associates, however, in its large consumption of grass seed, fully half of its food consisting of this element, panicums, pigeon-grass, and allied grasses being apparently preferred. It feeds on cultivated millets. Mr. F. F. Crevecoeur, of Onaga, Kans., states that the tree sparrow is as much of a pest as the English sparrow in damaging shocks of Hungarian millet which are not securely covered in the fall and winter. Mr. Crevecoeur sent in a score of stomachs of tree sparrows which were crammed full of seeds of millet. But in sections where millet seed is not left exposed the birds are very serviceable, for they then turn their attention to such weeds as pigeon-grass, crab-grass, poverty grass (*Aristida*), and sheathed rush grass. They also feed to a limited extent on the seeds of other grasses. Each of several of the stomachs examined contained from 100 to 200 seeds of timothy, June grass, or broom sedge.

Nearly two-thirds of the vegetable food that is not grass seed is derived from such plants as ragweed, amaranth, lamb's-quarters, and

various kinds of polygonums. The remainder is made up of a variety of seeds none of which taken alone plays any significant part in the diet, but which amount altogether to 10 percent of the food. These are for the most part wild sunflower, golden-rod, chickweed, sedge, birch, purslane, wood sorrel, violet, and sheep sorrel. According to Dr. Warren, the tree sparrow feeds on wild grapes and cedar berries, but the laboratory investigations have thus far failed to show any remains of fruit other than some seeds of blackberry and blueberry, which were picked up in early spring.

The animal food during the bird's stay in the United States amounts to 2 percent, a quantity too small to be of much economic interest. It consists of weevils and other beetles, such as ground-beetles and rove-beetles, also wasp-like insects, ants, caterpillars, bugs, grasshoppers, and spiders.

The value of the bird lies chiefly in the fact that barely 1 percent of its food consists of grain, while more than 50 percent is made up of weed seed. As it is one of the most abundant species, fairly swarming in the hedge rows that skirt the fields, it is capable of rendering considerable service to agriculture.

CHIPPING SPARROW.

(*Spizella socialis* and *Spizella s. arizonæ*.)

The chipping sparrow breeds in every State in the Union (with the possible exception of Florida), in Canada, and on the table-lands of Mexico. Its breeding range includes four life zones, the Canadian, Transition, and Upper and Lower Austral, but in autumn the general migratory movement carries all the birds into the Lower Austral and farther south—that is to say, into the Gulf States, Cuba, and Mexico.

This little red-capped bird, that often builds its horse hair-lined nest in the vines of the porch, is one of the best known of the native sparrows. Its semi-domestic habits cause it to be a general favorite, despite the fact that it is not gifted with pleasing vocal powers, but utters only an incessant metallic chip, and a song that suggests the note of a distant cicada. The eggs are a delicate robin's-egg blue spotted at one end with black, which is exceptional, most sparrow eggs having a whitish ground color overlaid with brownish markings. The two broods of from three to five young reared each year consume great quantities of caterpillars and grasshoppers. Dr. Clarence M. Weed has seen a chipping sparrow carry 50 caterpillars to its young in twelve hours.[1]

In its own feeding the bird is a noted destroyer of different caterpillars. Mr. E. H. Forbush speaks of its eating cankerworms and brown-tail-moth, tent, and gipsy-moth caterpillars:[2] Dr. B. H. Warren has

[1] Bull. No. 55, N. H. Coll. Agr. Expt. Sta., 1898.

[2] Mass. Crop Rept., Bull. 3, pp. 33–36, July, 1900.

seen it preying on the army worm;[1] Dr. Weed, quoting Miss Soule, states that it attacks the moths of the forest tent caterpillar,[2] an insect which has recently seriously damaged the maple-sugar industry in New England; and many observers have stated that it feeds on cankerworms and cabbage worms. I have never seen chipping sparrows feeding on cabbage worms, although I have frequently watched them hopping about among or near cabbages which were badly infested with worms.

Mr. Henry W. Olds states that a chipping sparrow visited his pea patch and busily fed on the pea lice which were seriously injuring the vines. I have found chipping sparrows at Marshall Hall, Md., feeding on the same insect. This pest (*Nectarophora destructor*) is comparatively new to science, having been first described in 1899, but during that year it caused a loss to the pea crop of Maryland of $300,000.[3]

Audubon states that the chipping sparrow takes berries,[4] and Mr. Percy Moore, of Philadelphia, reports that it feeds on wild cherries. Prof. F. E. L. Beal says that he has occasionally seen it taking a few cultivated cherries. Mr. F. C. Kirkwood calls attention to a very peculiar habit it has of sipping the sap of grapevines.[5]

Two hundred and fifty stomachs have been examined, collected from March to November, and throughout the country both in the East and West, principally, however, from New England to Virginia and from the States of Kansas, Iowa, Illinois, and California, the greater part of the western chipping sparrows coming from the last-named State. More collections were made in summer and early autumn than at any other season. Of the contents of these stomachs the total animal food, consisting of insects with an occasional spider, amounts to 38 percent; the vegetable food to 62 percent. Of the vegetable food, 4 percent is grain, principally oats; 48 percent grass seed; and 10 percent other seeds, such as clover, ragweed, amaranth, wood sorrel, lamb's-quarters, purslane, chickweed, knotweed, and black bindweed. Twenty-six percent of the grass seed is crab-grass and pigeon-grass, chiefly the former, the rest consisting of timothy, orchard grass, and other grasses. The seeds of crab-grass, whenever they can be obtained, form the most important part of the diet. During the last of August there were collected a dozen chipping sparrows that were feeding in a flock amid some crab-grass and other weeds which were getting the upper hand in a small garden, about an acre in extent, and it was found that the stomach of every one of the birds

[1] Penn. Agr. Rept. 1896.
[2] Bull. No. 75, N. H. Coll. Agr. Expt. Sta., p. 121, 1900.
[3] Proc. Eleventh Ann. Meeting Assn. Economic Entomologists, pp. 94–99, 1899.
[4] Birds of America, Vol. III, p. 80, 1841.
[5] Birds of Maryland, p. 335, 1895.

was crammed full of the seeds of crab-grass. The much smaller consumption of ragweed, amaranth, lamb's-quarters, and polygonum than on the part of tree, white-throated, and song sparrows is probably due to the smaller and less powerful digestive organs of the chipping sparrow.

No small service is rendered in destroying weed seed, but the utility of the species is manifested most strikingly in its animal food, three-fourths of which consists of noxious insects, principally caterpillars, weevils, grasshoppers, and leaf-beetles. Of the 38 percent of animal matter, weevils constitute 6 percent; leaf-beetles, 2 percent; other Coleoptera, including predaceous ground-beetles, dung beetles, click-beetles, and May-beetles, collectively, 3 percent; caterpillars, 9 percent; grasshoppers, 10 percent; and miscellaneous animal matter, consisting of leaf-hoppers, true bugs, ants, spiders, and parasitic wasps, 8 percent. The maximum monthly average of weevils, 16 percent, is attained in May. In June, when 93 percent of the food is composed of insects, grasshoppers form 36 percent, caterpillars 25 percent, and leaf-beetles 6 percent.

On the one side only 1 percent of the food consists of useful insects (predaceous beetles and parasitic wasps), while more than 25 percent is made up of insect pests; and on the other side, grain composes only 4 percent, in contrast to weed seed, which constitutes 40 percent. These figures clearly show the good service rendered to agriculture.

The food habits of this sparrow will receive further consideration in connection with those of the next species—the field sparrow.

FIELD SPARROW.

(*Spizella pusilla* and *Spizella p. arenacea.*)

The field sparrow (see fig. 16) summers in the northern half of the United States east of the Rocky Mountains and in southern Canada, and winters in the Southern States.

It can perhaps best be distinguished from the many small species of ground-colored birds by its reddish beak. It is thoroughly commonplace in appearance, and in habits is much shyer than the chipping and song sparrows, which may be called dooryard birds. Often seen in the same weed patch with these sparrows, it is nevertheless, as its name indicates, a lover of open lands. Here it builds its nest, generally among some small briers, and during the season rears two to three broods of three or four each. Its food habits are very similar to those of the chipping sparrow, as would naturally be expected, since both belong to the same genus. Forbush has found it preying on plant lice, tent caterpillars, cankerworms, and the caterpillars of the brown-tail moth.[1]

[1] Mass. Crop Rept., Bull. 3, pp. 33–36, July, 1900.

The laboratory investigation includes 175 stomachs, collected during every month of the year, from 15 States and the District of Columbia, chiefly in New York, Massachusetts, and the District of Columbia in the East, and Kansas and Wyoming in the West. Of the total food they contained 41 percent was animal matter and 59 percent vegetable matter. Of the animal material weevils form 2 percent; leaf-beetles, 2 percent; ground-, tiger-, click-, and May-beetles, collectively, 9 percent; caterpillars, 4 percent; grasshoppers, 6 percent; leaf-hoppers, true bugs, sawflies, ants, flies, and spiders, taken together, 14 percent, and parasitic wasps, 4 percent. This last item is the principal point wherein the field sparrow differs in food habits from the chipping

FIG. 16.—Field sparrow.

sparrow—a difference that is not to the advantage of the record of the species from an economic standpoint, since, as has been shown, these wasps are dangerous parasites of many caterpillars. Of the vegetable food 51 percent consists of the seed of grasses, for the most part such species as crab-grass and other panicums, pigeon-grass, broom sedge, poverty grass (*Aristida*), and sheathed rush grass. Seeds of such weeds as chickweed, lamb's-quarters, gromwell, amaranth, purslane, spurge, wood sorrel, and knotweed amount to 4 percent. The percentage of timothy is insignificant, but that of oats is comparatively large, as they constitute 4 percent of the food.

The amount of grain taken during most of the year is about 4 percent, but in August the bird visits oat stubble and feeds on oats, often to the extent of a quarter of its diet. The chipping sparrow has the same habit. Apparently no such predilection exists in the case of wheat. During the last week in June a dozen sparrows of both these species were collected in a wheat field at harvest time. They were, however, not eating wheat, but were feeding on insects and weed seed. Some of the oats that are found in the stomachs are obtained from horse droppings. This is particularly true in the case of the chipping sparrow, a species which is often found foraging along roadsides.

Both of these sparrows feed very little on any seeds other than those of grasses, in which propensity they are like the tree and lark sparrows. They subsist less on ragweed than any other species of upland sparrows, and take comparatively little lamb's-quarters or amaranth, but at times show a marked liking for wood-sorrel, chickweed, purslane, or some of the smaller-seeded species of polygonums.

Both of these birds are abundant and useful tenants of the farm, but comparison shows the chipping sparrow to have the more favorable food habits. It destroys fewer beneficial insects and more pests than its congener.

JUNCO.

(*Junco hyemalis* and subspecies.)

The junco (see frontispiece), unlike the chipping and field sparrows, is not a summer but a winter bird so far as most of the agricultural districts of our country are concerned. It is a bird of the Canadian and upper Transition life zones, and hence breeds principally in the mountains or near the Canadian border. In winter it migrates south, spreads over the whole of the United States—though less abundant in the northern portions—and ranges as far south as Mexico.

The best-known junco is the slate-colored, familiarly known as the snowbird, or sometimes black snowbird, in contradistinction to the snowflake of the Northern States. It comes from the north with the first frost, and is as definitely associated with the beginning of cold weather as the robin is with the first breath of spring. In its winter home the bird is very friendly and hops up to the doorstep for crumbs with the same engaging confidence manifested by the chipping sparrow in summer. But should the expected crumbs be wanting, it is not disturbed. With a sharp chirp sounding like the click of two marbles against each other it is off to the weed patches, or to the barn if the weeds are buried under the snow. From the haymow it can procure food, even though the snow be fence deep; and at such times, or during blizzards, a few meals of hayseed are not distasteful to it. But as soon as its forced retirement is concluded—that is, when the inclemencies that drove it to shelter have

abated—it will be found, often in company with other winter sparrows, on the sunny hillsides which bristle with ragweed, cracking the seeds that are spread on the snow-covered ground.

The food habits of the junco are such as commend it highly to the farmer. An examination has been made of 299 stomachs, collected during every month in the year except May. They were secured chiefly along the Atlantic seaboard, but a fairly large number were obtained in the central part of the country and California.

The food for the year as a whole, as indicated by these stomachs, consists of animal matter 22 percent and vegetable matter 78 percent. The animal matter is distributed as follows: Orthoptera and Lepidoptera, each 2 percent; Hymenoptera, 3 percent; Coleoptera, 6 percent; miscellaneous insects, largely Hemiptera, 7 percent; and spiders, with a few snails and other invertebrates, 2 percent.

It will be convenient to consider the summer and winter feeding habits separately. The summer diet, as far as can be judged by the contents of 65 stomachs collected from June to August, inclusive, mainly in the mountainous regions of California and on Roan Mountain, North Carolina, is 49 percent animal matter and 51 percent vegetable matter. Insects of the useful class comprise 1 percent of ground-beetles and 5 percent of parasitic Hymenoptera. Insects belonging to the injurious category amount to 25 percent of the total food and are distributed as follows: Leaf-beetles, 2 percent; weevils (Rhynchophora), 8 percent; caterpillars, 4 percent; grasshoppers, 5 percent; and miscellaneous insects, largely true bugs, leaf-hoppers (Jassidæ), click-beetles, and longicorn beetles (Cerambycidæ), 6 percent. Neutral insects, mainly small dung-beetles, ants, and other insects of little or no economic importance, amount altogether to 16 percent of the food.

The vegetable food consists of various seeds, 49 percent of the total, and wild fruits, 2 percent of the total. The seed matter is distributed as follows: Grass seed, 5 percent; polygonum seed, 8 percent; violet seed, 9 percent, and miscellaneous seeds, mainly those of sedge, sheep-sorrel, wood sorrel, purslane, and chickweed, 2 percent. The remaining vegetable food is composed of wild fruit, and includes blueberries, blackberries, strawberries, and elderberries.

The summer feeding habits of the junco, although of a character highly creditable to the species, are not of much economic importance, since the habitat of this bird during the breeding season is largely beyond agricultural areas. But when the bird migrates to fertile districts and extends over the whole of the United States in autumn to remain until spring, it becomes a most important and useful bird. The animal food at this time, which is of the usual character, is too small to be important. The vegetable food, which constitutes 91 percent of the diet, may be conveniently divided into three nearly equal parts; the first of which is largely timothy, broom

sedge, sheathed rush-grass, pigeon-grass, crab-grass, and other panicums, paspalum, and a small quantity of grain; the second comprises ragweed and polygonums; and the third includes the seeds of various plants the majority of which are such weeds as amaranth, lamb's-quarters, chickweed, purslane, tick-trefoil, vetch, gromwell, wood sorrel, sedge, sheep-sorrel, wild sunflower, and Russian thistle. The seeds of amaranth and lamb's-quarters are by far the most important in the diet. Few other sparrows eat as many of these seeds as the junco, which feeds on them chiefly in March when, doubtless, other and more palatable seeds are too scarce to be easily obtained.

The effect of the junco during its stay on agricultural land is that of an unmixed benefit, because the good done by its extensive consumption of weed seeds is not counterbalanced by any real harm; even the slight tendency toward grain eating is practically harmless, since most of the grain eaten consists of waste kernels.

SONG SPARROW.

(*Melospiza melodia* and subspecies.)

The song sparrow (see fig. 17), unlike the junco, occupies agricultural areas in summer. It breeds throughout the United States, including Alaska south of Unalaska, and is found also in Canada and Mexico. In winter there is a shifting southward, but the species is still to be found in most of the States except the northern tier.

FIG. 17.—Song sparrow.

The bird honestly merits its title of song sparrow, for its bright, canary-like lay is one of the most attractive voices of the spring, and is familiar to many that do not know the identity of its author. In habitat it differs slightly from both field and chipping sparrows: it is not so often met with in the open country as the one, or in the orchard as the other, but is most likely to be found inhabiting bushes along water courses. Sometimes, however, it frequents the shrubbery near buildings, in which case it may often be seen, in company with worthless English sparrows, hunting about

the barnyard for hayseed. It seeks its food on the ground, running in a peculiar mouse-like way through grass or weeds.

Its food, as indicated by the examination of 401 stomachs from 26 States and British Columbia, collected during every month in the year, consists of animal matter, insects with occasionally a spider or snail, 34 percent; and vegetable matter, mostly seeds, 66 percent. That the bird haunts damp localities is well shown by certain articles of its food, such as wild rice, sedge, smartweed, tall smooth panicum (*Panicum virgatum*), and spreading panicum (*Panicum proliferum*), sand-fleas, aquatic snails, tiger-beetles, May-flies, and dragon-flies. But it often leaves its favorite resort, along water courses, and seeks its food on the uplands with other species of sparrows, feeding on woodbine berries with white-throated sparrows, picking up seeds of crab-grass and ragweed in company with juncos and tree sparrows, devouring earthworms on the lawn with the robin, and even fighting with English sparrows for its share of bread crumbs upon the city street. When raspberries are ripe it will once in a while assist the catbird and brown thrasher in removing some of the choicest and most luscious. In Maryland it has a habit of hunting round wheat-straw ricks for grain that has not been entirely threshed out. Still, taken as a whole, the food habits of this popular cheery-voiced sparrow are not very different from those of a number of other species.

Of the vegetable portion (66 percent) of the year's food, 3 percent consists of ragweed, 5 percent of grain, 16 percent of polygonum and related seeds, 24 percent of grass seed, and 18 percent of miscellaneous seeds, such as those of wild sunflower, amaranth, lamb's-quarters, clover, gromwell, rib-grass, wild solanum, purslane, spurge, wood sorrel, dandelion, chickweed, dock, and sheep-sorrel. The last two are seldom eaten by most other birds. More polygonum seed is taken by the song sparrow than by any other sparrow, largely because most polygonums grow in moist places where song sparrows are often very abundant. Several species of polygonums are weed pests on low ground, and much good is done by the systematic destruction of their seeds by the song sparrow during every month in the year. More than half the grass-seed food belongs to such troublesome species as crab-grass and pigeon-grass. The bird is so numerous that it must destroy large quantities of these weeds. The seeds of other grasses, such as timothy, paspalum, old-witch grass, barnyard grass, tall smooth panicum, spreading panicum, beard-grass (*Andropogon*), orchard grass, sheathed rush-grass, yard-grass, wild rye, wild rice, and others form about 8 percent of the food.

The song sparrow, like the white-throated, white-crowned, and fox sparrows, manifests a taste for fruit, especially during July, when blackberries, strawberries, raspberries, blueberries, mulberries, and wild black cherries are eaten to the extent of nearly 8 percent of the food. This diet is largely abandoned when the weed-seed harvest is

mature, though the bird occasionally feeds with others on the ripening crop of wild fruits during late summer and autumn. It has been observed eating elderberries, wild grapes, pokeberries, bayberries, and berries of the woodbine; but in spite of this taste and the bird's abundance among cultivated berry patches, it never, to any appreciable extent, does any damage to cultivated fruit.

Insects amount to about one-third of the annual diet, and from May to August, inclusive, when they are eaten most freely, compose more than half the food. Diptera constitute 2 percent of the year's food; Hemiptera, 3 percent; Hymenoptera, 4 percent; Lepidoptera, 6 percent; Orthoptera, 7 percent; Coleoptera, 9 percent, and miscellaneous insects, principally Neuroptera, Plectoptera, and Ephemeridæ, 1 percent.

The kinds eaten are for the most part the same as those taken by the chipping sparrow and field sparrow. The greater part of the Diptera are not the common house-flies, but mosquito-like flies belonging to the families Chironomidæ and Tipulidæ. They are eaten in both the larval and imago stages. Occasionally imagos of some species of horseflies furnish a part of a meal. The Hemiptera belong to both the heteropterous and homopterous divisions of the order. The Heteroptera include small bugs of nauseous odor, largely soldier bugs, leaf bugs (Capsidæ), and assassin bugs, and are usually species of little or no economic importance. The Homoptera are practically all leaf-hoppers (Jassidæ). Cercopidæ, the little bugs which are responsible for the so-called 'frog spit' or 'snake spit' which is often found adhering to grass in early summer, are sometimes eaten.

Half of the Hymenoptera entering into the food comprise ants belonging to both of the principal families Formicidæ and Myrmicidæ. It is highly probable that most of the ants are taken while flying, as many species of birds secure their ant food in the air. One-quarter of the hymenopterous food, amounting to about 1 percent of the total food for the year, consists of such parasitic species as flies (Braconidæ), ichneumon flies (Ichneumonidæ), and certain wasps (Scoliidæ); the remainder is made up of a few saw-flies, some joint-worm flies, cuckoo flies, and a number of the smaller bees (*Andrena*, *Halictus*, and other plant-fertilizing species).

The Lepidoptera (all moths) are principally larvæ of Noctuidæ, such as cutworms and army worms. They also include larvæ of Geometridæ and the occasional pupa of a tineid moth (Coleophora). Mr. E. H. Forbush discovered that the song sparrow will eat hairy caterpillars,[1] but none but the smooth kinds have thus far been found in the stomachs examined in the Biological Survey. In its destruction of Lepidoptera the song sparrow renders considerable service, especially during May and June, when 25 percent of its food consists of these pests. At this time it makes a business of hunting on the ground

[1] Mass. Crop Rept., p. 36, Sept., 1899.

for cutworms, which, if allowed to live and mature, would undoubtedly do much damage. Several song sparrows were collected in New York State during an invasion of army worms in 1896, and it was found that they had preyed on these pests to a very considerable extent. Cankerworms and the larvæ of the gipsy moth and the brown-tail moth enter into the food, according to the observations of Mr. E. H. Forbush.[1]

Orthoptera form only 7 percent of the annual food, but amount to 28 percent of the food for August. The short-horned grasshoppers eaten are chiefly the same kinds as those selected by other birds, that is, they comprise the various abundant species of the genus *Melanoplus*, such as the red-legged locust and the Rocky Mountain locust. Long-horned grasshoppers of the genera *Orchelimum*, *Scudderia*, and *Xiphidium*, which habitually infest moist meadows, are freely eaten. Crickets are, apparently, much relished. A number of stomachs contained several, and in one were found no less than 10.

Beetles seem to be eaten during every month in the year, but become most conspicuous in the stomachs in late spring and early summer. They are chiefly ground-beetles, leaf-beetles, click-beetles, weevils (Rhynchophora), and members of the families Histeridæ and Scarabæidæ; but a few long-horned beetles, tiger-beetles, and members of the families Lampyridæ and Mordelidæ are also taken. Ground-beetles constitute but 1 percent of the food, and the species that make up this insignificant percentage are the smaller, less useful forms, such as *Agonoderus*, *Platynus*, *Bembidium*, *Cratacanthus*, *Anisodactylus*, *Amara*, *Pterostichus*, and the smaller species of *Harpalus*. As sparrows are ground feeders, it would seem natural that more of the valuable ground-beetles would be destroyed by them than by birds that are more arboreal in their habits; but as a matter of fact they consume fewer than most of our common birds; and the larger, more useful species, which work the greatest destruction among insect pests, and which are eaten freely by many of the common birds of the farm, sparrows do not molest.[2] In July, 5 percent of the food of the song sparrow is composed of leaf-beetles, principally small species of the genera *Colaspis*, *Crepidodera*, *Chætocnema*, *Hæmonia*, *Odontota*, *Systena*, and to some extent *Epitrix;* and for the year as a whole these amount to 1 percent of the diet. Click-beetles and Histeridæ seem to be eaten only to a very slight extent, but weevils form the most important element of the beetle food, as they do in the case of most sparrows, amounting to 4 percent of the total food, and in June attaining a maximum of 11 percent. It seems strange that the bird should be apparently so little

[1] Mass. Crop Rept., Bull. 3, pp. 33–35, July, 1900.

[2] Such effective carabids as *Carabus*, *Scarites*, *Pasimachus*, *Cychrus*, *Chlœnius*, and *Calosoma*, which are often found in the stomachs of larger birds, have never been met with in the stomachs of sparrows.

baffled by the wonderful protective adaptations of these beetles, many of which harmonize with their surroundings so completely as to be practically invisible to human eyes. The particular weevils most often selected include such forms as *Baris*, *Sphenophorus*, *Centrinus*, *Sitones*, *Phytonomus*, and *Tanymecus*.

The Scarabæidæ eaten are for the most part the smaller forms of dung-beetles, especially *Aphodius fimetarius* and *Aphodius inquinatus*. The song sparrow does not, as a rule, attack such large forms as the May-beetle, but it probably feeds to some extent on medium-sized closely related forms, *Serica vespertina* and others, as it frequently preys on beetles of this size, such as those of the genus *Anomala*.

The rest of the animal food amounts to 2 percent of the total food, and is made up of snails, largely such aquatic species as pond snails; spiders, chiefly running species belonging to the family Lycosidæ; and some few thousand-legs of the genus *Julus* and closely allied forms.

Taking the food habits of the song sparrow as a whole, it will be readily seen that this bird does much more good than harm and is worthy of protection and encouragement. Only 2 percent of the food consists of useful insects, while 18 percent is composed of injurious insects; and grain, largely waste, amounts to only 4 percent, while the seeds of various species of weeds constitute 50 percent.

LINCOLN'S SPARROW.

(*Melospiza lincolni.*)

Lincoln's sparrow breeds in the highest parts of the Rocky Mountains and the Sierra Nevada and from the northern tier of States to Labrador and the Mackenzie and Upper Yukon rivers. In winter it is found throughout the southern half of the United States, but is rare and locally distributed in the East. To the untrained eye, it is practically indistinguishable from its congener, the ubiquitous song sparrow; but it is as distrustful as the song sparrow is confiding.

Only 31 stomachs of this species have been examined. These were collected during the months of February, April, May, September, and October, mainly in Massachusetts and New York. The food during these months, as indicated by the stomachs, consists of animal matter, 42 percent, and of vegetable matter, 58 percent. The animal matter is made up of 2 percent spiders and millepeds and 40 percent insects. Useful insects, largely Hymenoptera, with some predaceous beetles form 4 percent of the food, and injurious insects, 12 percent. Neutral insects, including beetles, ants, flies, and some bugs, amount to a fourth of the food. More ants (principally Myrmicidæ) and fewer grasshoppers are destroyed than by the song sparrow. The vegetable matter is divided as follows: Grain, 2 percent; seeds of ragweed and various species of *Polygonum*, 13 percent; grass seed, 27 percent, and miscellaneous seeds, principally weeds, 16 percent.

SWAMP SPARROW.

(*Melospiza georgiana.*)

The swamp sparrow breeds from southern New York, northern Illinois, and the Dakotas north to Manitoba, Labrador, and Newfoundland, and winters from southern New England, southern Illinois, and Kansas to the Gulf. It is distinguishable from the song sparrow by its unstreaked breast and brick-red crown. It is a timid bird and never abandons the tussocks and reeds of the marsh to come up to the shrubbery of the lawn or dooryard. Nor does it often leave its swamp to forage on cultivated land, a characteristic which makes it of less economic importance than many of our sparrows. Such species, if they figure at all in rural economy, act simply as a check on certain insects which might otherwise become abundant and spread from the swamp to farm lands.

The food from February to November, exclusive of March, as indicated by the examination of 72 stomachs, principally from Massachusetts, Connecticut, New York, and Pennsylvania, is divided as follows: Animal matter, 47 percent, nearly all insects; and vegetable matter, 53 percent, almost entirely seeds. An interesting fact in connection with the feeding habits was brought out in the study of a caged bird. It showed an aversion to picking up seeds from its seed cup, preferring to take them from the surface of its drinking vessel. This suggests the idea that it is possible that the bird was accustomed, in its swampy home, to gather seeds from the water, though it may be that it merely preferred wet seeds to dry, on account of having been used to seeds that were moist from contact with the damp ground. The swamp sparrow takes more seeds of polygonums than most birds, and eats largely of the seeds of the sedges and aquatic panicums that abound in its swampy habitat. The giant ragweed (*Ambrosia trifida*) is also well represented in its stomach contents.

Of the insect food (45 percent of the total) grasshoppers, etc., amount to 2 percent; parasitic and predaceous insects to 6 percent; caterpillars, etc., to 9 percent; and leaf-beetles and weevils to 11 percent. The remaining 17 percent consists of bugs (Heteroptera and Homoptera), ants (Formicina), flies (Diptera), and the smaller dung-beetles. The bird shows a marked taste for ants, one-seventh of the stomachs examined containing these insects, especially those of the family Myrmicidæ. Although many of the insects eaten by the swamp sparrow belong to families generally classed as injurious or beneficial, yet the particular species taken are mainly such as inhabit only swamps, and so have very little, if any, economic value.

FOX SPARROW.

(*Passerella iliaca.*)

The fox sparrow (see frontispiece) is one of the birds that characterize the Hudsonian life zone—that is to say, it is found breeding in

the vast forest which stretches from Labrador to Alaska. Summering in this region, as it does, it is of no economic importance until it migrates south in autumn into the agricultural lands of Canada and the United States. It then spreads over the whole country to the Gulf of Mexico.

The fox sparrow is the largest sparrow in the United States, exclusive of Alaska. It is found often in the woods, where it is likely to be mistaken for a hermit thrush on account of its large size, reddish color, and spotted breast. Its song is utterly unsparrowlike, a unique performance that seems not in the least akin to bird music, but more like the soft tinkling of tiny silver bells. In food habits it is a true sparrow, showing some resemblance, however, to the cardinal grosbeak (also a member of the finch family) in its fondness for berries, or, as is more likely, berry seeds. Both the fox sparrow and the cardinal have powerful bills, and are thus able to feed on seeds which weaker-billed species of seed-eating birds can not crack.

The food, as indicated by the examination of 127 stomachs, collected principally in the Eastern States, and during every month excepting June, July, and August, consists of animal matter, 14 percent, and vegetable matter, 86 percent. The animal food is of little interest excepting in the month of April, when the bird begins eating largely of millepeds of the *Julus* group—20 percent of the food for the month consisting of these invertebrates—and at the same time develops such a taste for ground-beetles as to raise this item of its month's diet to 10 percent. The quantity of these useful insects destroyed during the summer, when the bird is in its home in the far north, is probably much less.

The vegetable food differs from that of most other sparrows, in that it contains less grass seed (only 1 percent), less grain, and more fruit, ragweed, and polygonum. Half of the food consists of ragweed and polygonum and more than a quarter of fruit. In its dependence on fruit the fox sparrow resembles the white-throated sparrow. It does no direct damage to cultivated fruit, though it occasionally eats the buds of peach trees and pear trees.[1] Bradford Torrey has observed it feeding on the fruit of burning bush (*Euonymus americana*).[2] C. A. Averill, Bridgeport, Conn., reports that he has found it eating the berries of the red cedar (*Juniperus virginiana*), and James H. Gaut, of the Biological Survey, says that he has seen it feeding on poke berries in November in Washington.

But although 28 percent of the food contents of the stomachs examined consisted of the seeds of berries and of fruit skin, it is safe to say that barely a third of this percentage represents actual fruit destruction, and that the remaining two-thirds of the seeds were eaten after the pulp of the fruit had been removed by other agents. In only 7 of

[1] Letter from F. H. Metcalf, Holyoke, Mass., 1890.

[2] Birds in the Bush, p. 220, 1885.

the 127 stomachs examined was there any fruit skin found, and the seeds in the stomachs were often broken, and were usually eaten at a time when the whole berry or fruit was not obtainable. Thus, seeds of blueberries and elderberries were found in stomachs collected in March, and broken stones of grapes and blackberries in stomachs collected in May. It is obvious that the fruit to which these seeds originally belonged had been destroyed long before the birds picked up the seeds.

DICKCISSEL.

(*Spiza americana.*)

The dickcissel (see fig. 18) formerly raised its broods over a considerable portion of the United States east of the Rocky Mountains; but two or three decades ago it abandoned the Eastern States and

FIG. 18.—Dickcissel (*Spiza americana*).

now rarely breeds east of the Allegheny Mountains. In autumn it migrates to Central and South America. In some localities it is known as the little meadowlark, because its coloring is like that of the meadowlark, even to the black locket on the breast of brilliant yellow. Most sparrows are gregarious, but dickcissels move about in pairs or little family groups. In many places they are so numerous that a score of individuals may be found in every hayfield and meadow; and the species is as characteristic of such localities as the

robin is of the New England lawn, or the mocking bird of the Florida plantation. The song consists of a series of monotonous insect notes, repeated insistently from early morn till late afternoon, resembling somewhat the heat-suggestive tones of the grasshopper. The nest is placed on the ground like those of many of the sparrows, but the eggs are wholly unlike most sparrow eggs; they are pale blue, and might easily be mistaken for those of the bluebird.

In food habits the dickcissel is particularly interesting. One hundred and fifty-two stomachs have been examined, collected, however, only during the somewhat limited period from May to August. The winter food is, therefore, not shown by these examinations, but Nehrling states that during that season the bird feeds on grass seed and weed seed.[1] Most of the stomachs examined in the laboratory were collected in Kansas, but some came from Minnesota, Wisconsin, and Texas. They contained animal matter to the extent of 70 percent (insects, with a few spiders) and vegetable matter to the extent of 30 percent, practically all seeds. The vegetable part of the food is probably not as creditable as it would have been had the stomachs been collected from more widely separated localities. Most of them were obtained by one collector in a certain part of Kansas where there were large millet fields, and naturally the birds helped themselves plentifully to this abundant supply of food. In the stomachs collected during August, more than a tenth of the food was millet. In sections where millet is not grown, however, or where it is sown and covered well, the dickcissel might prove very valuable in feeding on the seeds of pigeon-grass; for in the stomachs examined, the seeds of millet, pigeon-grass, and closely related species formed almost the whole vegetable food. Some species of panicum were slightly represented.

The dickcissel, like most other fringilline birds, eats grain, but its offenses in this way are trifling; 3 percent of the food contained in the stomachs collected in July was composed of oats, but this was the only grain (except millet) found in any of the stomachs examined. The autumn and winter fare is probably composed chiefly of such grass and weed seeds as are usually eaten by sparrows.

But it is the insect food that is of especial interest. This constitutes 68 percent of the diet from May to August, and is made up as follows: Diptera and Hemiptera, 1 percent; Hymenoptera, 2 percent; Lepidoptera, 8 percent; Coleoptera, 15 percent; and Orthoptera, 41 percent. The Hymenoptera are almost entirely useful species; ants were found in 3 of the 152 stomachs examined, a small quantity compared with the great numbers eaten by some of the sparrows, notably the white-crowned, the white-throated, and the savanna. The Diptera are all obscure forms, except some robber-flies that one bird had fed on. The Hemiptera include true bugs of both

[1] Our Native Birds of Song and Beauty, Vol. II, p. 231, 1896.

plant-feeding and predaceous habits. The lepidopterous element, which is exceedingly small in comparison with that of many other species, is composed of smooth caterpillars of the families Geometridæ and Noctuidæ, except that one bird, contrary to the habits of most species, had fed on a black caterpillar beset with bristling hairs. Moths are also preyed on, and from information obtained through experiments (see p. 48), it is highly probable that, as seems to be the case with the sharp-tailed sparrow and a number of others, the smaller dull-colored species, popularly known as millers, are snapped up whenever an opportunity offers.

The Coleoptera entering into the food comprise ground-beetles, including some of the very beneficial sharp-jawed species, 1 percent; leaf-beetles, mostly dark, obscure species, 1 percent; weevils (Rhynchophora), largely *Sitones* and species of similar habits, 3 percent; little dung-beetles (Scarabæidæ and Histeridæ), 4 percent; and click-beetles and small long-horned beetles, taken together, 2 percent.

But it is as a destroyer of grasshoppers that the dickcissel excels. If it ate twice the quantity of useful insects and grain and destroyed no weed seed at all, it would still be a useful species because of the enormous number of grasshoppers and crickets it consumes. From June to August, inclusive, half of its diet consists of these destructive insects. It feeds eagerly on short-horned grasshoppers (Acrididæ), long-horned grasshoppers (Locustidæ), and crickets (Gryllidæ). The stomachs examined contained more crickets and long-horned grasshoppers than those of any other bird whose food habits have yet been investigated by this Department. The short-horned grasshoppers eaten included such forms as are generally found in stomachs of birds, the red-legged locust (*Melanoplus femur-rubrum*) and the Rocky Mountain locust (*Melanoplus spretus*) as usual, being most common. During the invasion of the last-named species, Professor Aughey examined some stomachs of the dickcissel, and found in each the remains of these pests, one alone containing twenty-seven.[1]

The large consumption of Orthoptera seems odd when one bears in mind the statement of Wallace that "The whole order of Orthoptera, grasshoppers, locusts, crickets, etc., are protected by their colors harmonizing with that of the vegetation or the soil on which they live. * * * We need not adduce any more examples to show how important are the details of form and of coloring in animals, and that their very existence may often depend upon their being by these means concealed from their enemies."[2] But that birds are sharp-eyed enough to seek out a great many Orthoptera, is unmistakably shown by the food of the dickcissel, the grasshopper sparrow, the lark sparrow, and many other species.

[1] First Ann. Report U. S. Entomological Commission, App. II, p. 32, 1878.

[2] Natural Selection, p. 63, 1870.

About 2 percent of the food consists of such invertebrates as spiders and some few snails. The spiders belong to such terrestrial forms as the Lycosidæ and other ground-runners. There is, however, one notable exception in the case of a brood of nestlings. These were fed on a nonterrestrial spider (*Argiope*), a large, venomous-looking (though harmless) object as it rests in its web, resplendent with glossy black and brilliant yellow. Its gaudy color is supposed to be a protective device against birds.

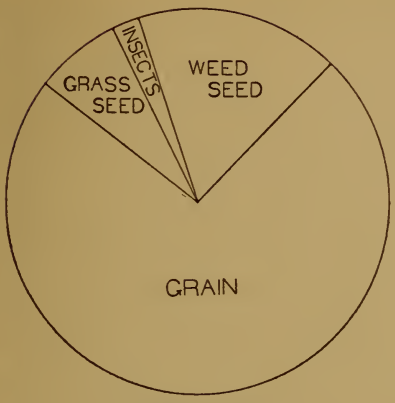
From the limited investigations thus far made, the dickcissel, like the lark sparrow, vesper sparrow, and grasshopper sparrow, proves to be a most useful insect destroyer, whose services to the farmer are important. It will be found especially helpful in keeping down grasshoppers, which always threaten to become over-abundant and cause great destruction among the crops.

ENGLISH SPARROW.

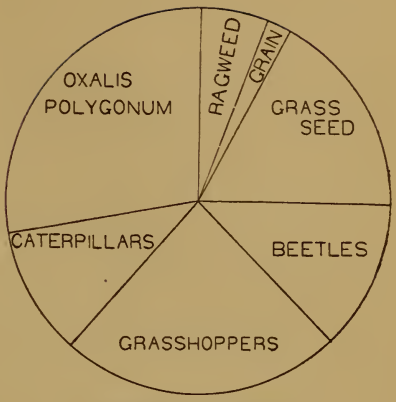
(*Passer domesticus.*)

The English sparrow, or, more properly speaking, the house sparrow of Europe and Asia (see fig. 19), was introduced into the United States about 1850 and has increased and spread until now it is one of the most abundant birds east of the Mississippi River. It does not, however, occur in the lower part of Florida and certain parts of Mississippi and Louisiana, nor in some portions of Maine, Minnesota, and North Dakota. West of the Mississippi River its range forms a tongue-like area extending to the base of the Rocky Mountains in Colorado, and includes Missouri, Kansas, Arkansas, Indian Territory, and parts of South Dakota, Texas, Oklahoma, and Nebraska. It is also found in isolated localities west of the Rocky Mountains, principally about Great Salt Lake, San Francisco Bay, near Portland, Oreg., and on Puget Sound, Washington. In Canada it is established to a greater or lesser degree in all the eastern provinces. It has recently penetrated to Manitoba, but has not yet otherwise secured a foothold to the north and west of

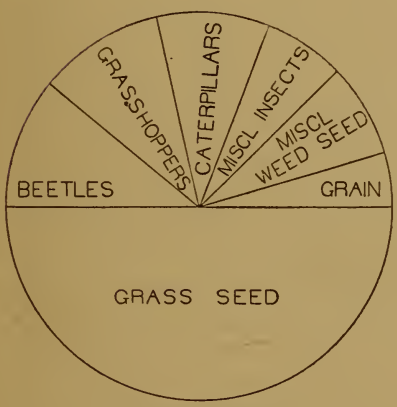
FIG. 19.—English sparrow.



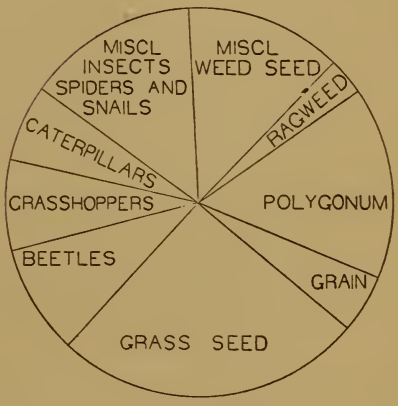
1. English sparrow.



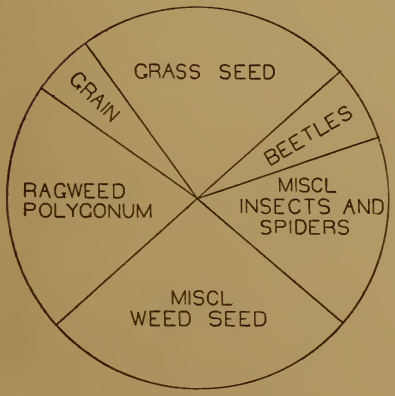
2. Grasshopper sparrow.



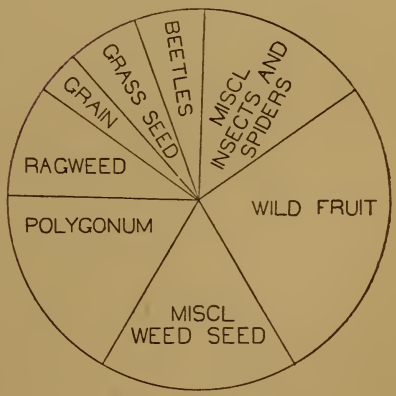
3. Chipping sparrow.



4. Song sparrow.



5. Junco.



6. White-throated sparrow.

DIAGRAM SHOWING PROPORTIONS OF FOOD OF SIX SPARROWS.

Ontario. Throughout its range it abounds chiefly in towns and villages, along roads, and about farms, and is not found in mountainous or forested districts.

The relation of the bird to man was investigated by the Department of Agriculture, and the results were published in 1889.[1] This investigation, which included extended field observation and the examination of more than 600 stomachs, showed the species to be a serious pest. Since the appearance of this publication 132 additional stomachs have been examined, and a special study has been made of the food of the young. For the latter purpose 50 birds from 3 days to 3 weeks old were collected during the last of June and the first of July, 1899, from a farming region in Virginia opposite Washington, D. C.

The 82 stomachs of adults were collected throughout the year in rural localities in Maryland, Michigan, New York, Pennsylvania, Ohio, Indiana, and Kansas. Animal matter, practically all insects, constituted 2 percent of the food, and vegetable matter, almost entirely seeds, 98 percent. Insects were taken chiefly during May and June, when they composed 10 and 8 percent respectively of the month's food. Of the 98 percent constituting the vegetable food, 7 percent consisted of grass seed, largely of plants of the genera *Zizania* (wild rice), *Panicum*, and *Chætocloa*, and notably crab-grass and pigeon-grass, and 17 percent of various weeds not belonging to the grass family. The grass and weed seeds taken are not noticeably different from those usually eaten by native sparrows. But what especially differentiates the vegetable food from that of all other sparrows is the large proportion of grain consumed, which formed 74 per cent of the entire food of the year and 90 percent of that of the period from June to August.

The examination of the contents of the stomachs of the 50 nestlings made an unfavorable showing for the species. It was found that instead of being exclusively insectivorous, like the young of all the native sparrows so far as known, the young English sparrows had taken 35 percent vegetable food, 2 percent being weed seed and 33 percent grain. The animal food was made up entirely of insects, and these were chiefly injurious. One percent of the food consisted of bugs, 3 percent of ants and other Hymenoptera, 4 percent of Lepidoptera, 8 percent of beetles, and 49 percent of grasshoppers. Three-fourths of the beetles were weevils, and practically all the grasshoppers were the short-horned (Acrididæ), the greater part of which belonged to the species *Melanoplus atlantis* and *Melanoplus femur-rubrum*. The destruction of these harmful insects is, of course, a service to agriculture; but it must be remembered that all the food of the nestlings of other sparrows consists of insects just as injurious, while one-third of the food of English sparrows is composed of grain.

As an insect destroyer the English sparrow does its best service by

[1] The English Sparrow in North America, Bull. 1, Div. Ornithology and Mammalogy, 1889.

destroying grasshoppers, principally in feeding nestlings, nearly half of the food of which, as shown, was found to consist of grasshoppers of the genus *Melanoplus*. Other Orthoptera are eaten to a slight extent. It is a common sight along roads to see the birds pursuing and capturing the large dust-colored grasshopper (*Dissosteira carolina*) which shows yellow underwings when it flies. Long-horned grasshoppers (*Locustidæ*), small grasshoppers of the genus *Tettix*, and, in one instance at least, the mole cricket (*Gryllotalpa*) were included in the orthopterous food found in their stomachs. The species of Lepidoptera preyed on are important pests. Whenever there is an uprising of army worms, the English sparrows feast on the abundant supply. They have been observed catching the moth also of the army worm. During spring and early summer, they remove many cutworms from lawns and, to a certain extent, feed on hairless caterpillars of shade trees. Occasionally they destroy a few hairy caterpillars: they eat the fall webworms and tussock-moth caterpillars, and sometimes feed on the moths and egg clusters of the latter species; they are included by Forbush among the birds seen to feed on the gipsy moth,[1] and they have been observed by Weed preying on the moths of the forest-tent caterpillar.[2] But that they do not habitually eat hairy caterpillars and should not be expected to act as a potent check upon such insects is evidenced by the fact that only 2 of nearly 700 stomachs examined contained hairy caterpillars.

The English sparrow feeds less on useful predaceous beetles than any other insect-eating bird investigated by the Department. Only three of the stomachs examined contained insects of this class. In one case a ground-beetle, and in the other two cases tiger-beetles were eaten. No dragon-flies were found in the stomachs examined, but an hour's field observation near the Department brought to light the fact that these useful insects, the natural enemies of mosquitoes, are relished by English sparrows. All about a pond at the base of the Washington Monument on the morning of May 21, 1898, the nymphs of a large species of dragon-fly (*Libellula pulchella*), which had emerged from the water and crawled up the stalks of yellow iris and other vegetation at the water's edge, were splitting open and the soft adults were tumbling out. The English sparrows, taking advantage of the helpless condition of these newly transformed insects, seized them and flew to the pavement above the pond, and, after some preliminary pecking, ate them, or carried them to their young. Along 200 feet of this pavement were 100 dragon-fly wings. Of the useful Hymenoptera, the English sparrow destroys few braconids or ichneumonids, but consumes a comparatively large number of scoliids (*Typhia* and *Myzine*). It has not been known to molest the common honey bee, but on the contrary if offered these insects in captivity, it invariably refuses them. It has nevertheless been observed feeding

[1] The Gipsy Moth, p. 208, 1896.

[2] Bull. No. 75, N. H. Coll. Agr. Expt. Sta., 1900.

on a small species of wild bee (*Halictus* sp.). Ants are quite frequently eaten. English sparrows, feeding on the ground, have often been seen to spring into the air and catch a flying ant, *Lasius* or *Tetramorium*. They also feed on *Monomorium pharaonis*.

The beetle element of their food is of varied importance. They prey on the harmless dung-beetles (*Aphodius*) that are selected by native sparrows and many other species of birds. They also eat May-beetles (*Lachnosterna*)—for the most part too hard-shelled for many of the native sparrows—which are very injurious to crops, but which should probably be counted as neutral in this case, since most of those eaten have been maimed or killed by arc lights along city streets. The destruction of weevils is productive of more benefit. These insects abound in city parks from which the English sparrows obtain much of their food, and where they destroy many of the pests, especially while feeding nestlings. The forms eaten include *Baris*, *Centrinus*, *Phytonomus punctatus*, *Sphenophorus parvulus*, and various species of *Sitones*. Unimportant leaf-beetles, such as *Colaspis brunnea* and *Chætocnema denticulata*, are eaten, but the more injurious kinds are not touched.

Hemiptera, both Heteroptera (soldier bugs of the genera *Euschistus* and *Podisus*) and Homoptera (leap-hoppers, plant-lice, scale insects, and cicadas), as well as Diptera (*Muscidæ* and *Tipulidæ*), are sometimes included in the sparrow's diet. Dr. L. O. Howard has found the bird feeding on the maple scale (*Pulvinaria innumerabilis*).[1] Mr. E. H. Forbush has observed it eating the eggs of the white birch plant-louse (1,478 eggs were found in one stomach), and also those of the larch plant-louse (*Chermes*).[2]

As regards the destruction of weeds, English sparrows would be far more effective in rural districts if they flew out into the fields to feed; but instead of this they limit their weed-seed eating largely to the barnyard and the immediate vicinity of buildings. Thus, during November, 1899, 50 English sparrows were seen eating seeds from a wagonful of ragweed which had been driven up to a barn. These same birds would not have flown into the field where the ragweed grew, because they preferred to stay near the barn and steal grain; but when a quantity of such food was brought to them they did not refuse it.

As has already been shown (see p. 26), English sparrows do effective work in destroying seeds of weeds in the public parks of cities and towns. This food does not differ materially in character from that of the native sparrows, consisting of such kinds as pigeon-grass (*Chætochloa glauca* and *C. viridis*), yard-grass, Bermuda or wire-grass, lamb's-quarters, crab-grass, sweet clover (*Melilotus alba*), knotweed, field mustard, black bindweed, smartweed, climbing false buckwheat, dandelion, sunflower (*Helianthus annuus*), and ragweed.

[1] Bull. 22, Div. Entomology, New Series, p. 12, 1900.

[2] Mass. Crop Report Bull. 3, p. 31, July, 1900.

In cities the grain that enters into their food is composed so largely of the semi-digested oats in horse droppings in the streets that it should not be allowed to weigh against the species appreciably in estimating the character of its food habits. But in rural districts it is largely drawn from man's supply. There is scarcely a grain crop which English sparrows do not habitually injure. They pillage the fields by thousands and cause great damage.

It appears, therefore, that there is little to be said in favor of the English sparrow. Its insectivorous habits are creditable as far as they go, but they are insignificant because the diet is almost exclusively vegetable; and while it is in the vegetable fare that the value of most sparrows consists, yet in the case of the English sparrow the damage to grain far overbalances the benefit of weed-seed destruction. Adding to this the injury it causes to buildings and statues in cities, there is no escape from the conclusion that the bird is a serious pest the extermination of which would be an unmixed blessing.

The obnoxious character of the English sparrow is widely recognized, and numerous attempts, by means of bounties and otherwise, have been made to rid the country of its presence, but with little success. The wariness of the bird, its hardihood, and its prodigious fecundity have thus far rendered all such efforts futile.

In the city of Boston, during 1899, a crusade was inaugurated through the efforts of the American Society of Bird Restorers. From March 13 to April 5, six men were employed in the Common and Public Garden destroying the nests and eggs. Five thousand nesting holes were plugged up, 4,000 nests destroyed, and 1,000 eggs broken, but no birds were killed. It is claimed that nearly half of the sparrows which normally breed on the Common and Public Garden were driven away. In May only 250 to 300 pairs of sparrows were found, while the number of pairs counted in the parks before the sparrow war began amounted to 500.

Much is always to be learned from an experiment of this kind, and other cities should profit by Boston's experience. There is reason to believe, however, that the present rapid supplanting of horse power by electricity will, by reducing the food supply of the birds, do more toward diminishing their numbers in the city parks than any plan for restricting their reproduction.

The amount of expense that may profitably be incurred in combating the sparrow will depend on circumstances, as in the case of the house rat and mouse; but it should be borne in mind that the bounty system has proved to be only an extravagant failure.

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